AD-A122 630 GREAT III EROSION AND SEDIMENT INVENTORY (SAVERTON MISSOURI TO CAIRO ILLINOIS)(U) SOIL CONSERVATION SERVICE COLUMBIA MO JUN 82 DACW43-81-C-0071 1/2

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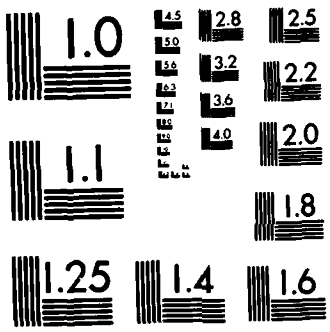

MICROCOPY RESOLUTION TEST CHART
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Erosion and sediment data for the Mississippi River and for 12 adjacent Water Resource Hydrologic Units from Saverton, Missouri, to Cairo, Illinois, were gathered and analyzed. An estimated 67 million tons of annual soil loss from the 12 Water Resource Hydrologic Units accounts for 6 percent of the average annual sediment load passing Thebes, Illinois. At present, an estimated 115 million tons of sediment on the average annually passes by St. Louis, Missouri. The weighted average sediment load of the Missouri River at

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Hermann, Missouri, between 1929 and 1952 was 243 million tons. This sediment load at Hermann has continued to decrease to 70.7 million tons in 1980. However, the sediment load at St. Louis has remained fairly constant since 1960. Beginning in 1966 an inverse relationship of discharge to suspended sediment concentration is documented for the Missouri River at Hermann. Since 1960, total discharge at St. Louis appears to be increasing.

In statistical analyses of suspended sediment concentrations at Hermann, Missouri, and Hannibal, Missouri, only 50 percent of the annual variation in sediment concentration could be explained by discharge. Untreated and treated analyses for grain size determinations of suspended sediment taken from the Missouri and Mississippi Rivers were significantly different. Specific surface area of sediment samples ranged from 87 to 203 square meters per gram. Surface area determinations using ethylene glycol monoethyl ether (EGME) were not significantly different for treated samples vs. native water samples. Aggregate size distribution measured from native water samples is not useful in computing surface area. Of four chemicals added during water treatment at the St. Louis, Missouri, and Alton, Illinois, water treatment plants to facilitate filtering and settling of impurities, only ferric sulfate correlated with suspended solids.

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GREAT RIVER RESOURCE MANAGEMENT STUDY

EROSION and SEDIMENT INVENTORY

I. INTRODUCTION

The Mississippi River, made legendary by Mark Twain, gathers runoff from 31 states and two Canadian provinces. The 1.5 million square mile watershed of the Mississippi River is the third largest watershed in the world. Millions of people live along the banks of this 2,500 mile waterway. Over 500 kinds of animals and a multitude of plant communities thrive in and along this great river.

Man, in his progress, has put the river to many varied and sometimes conflicting uses. The pressures of man's use of the river are feared to be degrading the environmental qualities of the river. More information is needed on the complex interactions of man's uses of the river's resources and the macro and micro environments of the river.

The total study program includes three Great River Environmental Action Teams (GREAT), which have the responsibility for the river reaches from St. Paul, Minneapolis, to Guttenberg, Iowa (GREAT I); Guttenberg to Saverton, Missouri (GREAT II); and Saverton to the confluence of the Ohio (GREAT III). This report is limited to the GREAT III study area. The GREAT III study area includes parts of the Upper Mississippi and Middle Mississippi areas.

The study programs and recommendations of the three GREAT teams will be brought together into a river management strategy for the entire Upper Mississippi River. The goal of the study is to present to Congress and the people a river resource management plan that is, above all, realistic - a plan that is technically and economically sound, socially and environmentally acceptable, and capable of being put into action within a reasonable period of time.

Erosion and Sediment Study

The purposes of the Erosion and Sediment Study are to inventory, measure, and evaluate sediment movement in channel systems; relate these sediments to soil losses on erosion source areas; evaluate the effects of erosion and sediment deposition on the Mississippi River flood plain; identify relationships between sediment and water treatment costs; present data in a format allowing ready identification of environmental effects and interactions; and recommend solutions to identified problems. The Erosion and Sediment Work Group (E&SWG) effort was to have resulted in a technical report addressing concerns, problems; listing potential measures; containing impact assessments and evaluations. The GREAT III study was originally funded as a three stage planning process. Termination of FY 83 funding and no promise of future funding resulted in documentation of ongoing studies early in the second planning process stage. Due to curtailment of the GREAT III study, only the inventory and assessment of existing data, documented in this report, was accomplished by the E&SWG.

Erosion and Sediment Study Area

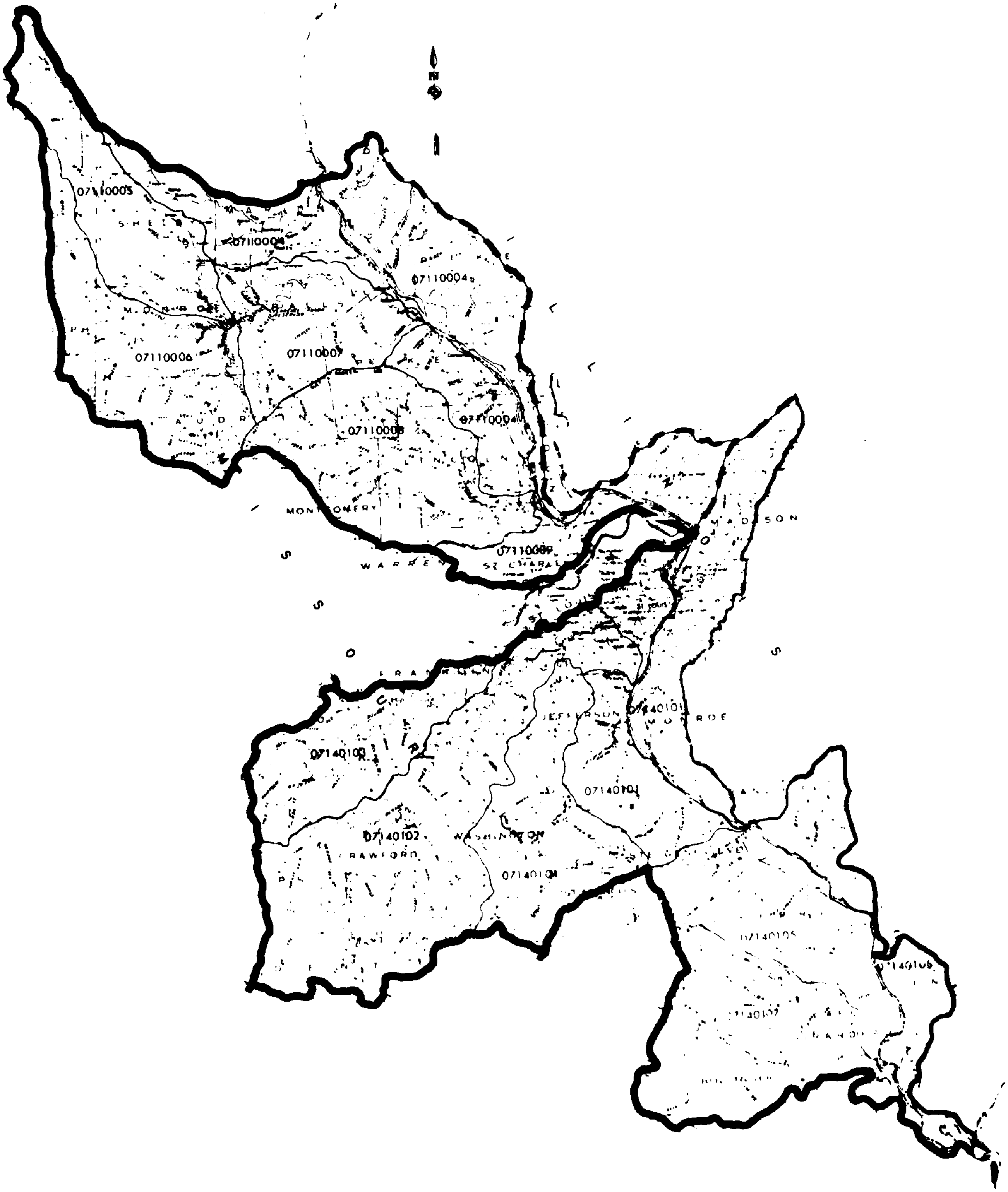
The study area includes the Mississippi River flood plain from Saverton, Missouri, river mile 303, to Cairo, Illinois, river mile 0, and 12 Water Resources Hydrologic Units adjacent to the Mississippi River corridor (Figure 1). For ease of study, the 12 hydrologic units have been aggregated into six drainage areas (Table 6) excluding the Mississippi River flood plain. Sediment transported through and deposited in the GREAT III area has source areas inside, as well as upstream, of the GREAT III area. The six drainage areas included in the study area comprise 13,907 $mi.^2$ or 1.9 percent of the drainage area of the Mississippi River, 717,397 $mi.^2$, at Birds Point, Missouri, river mile 2. The study addresses incoming sediment, study area sediment, and outgoing sediment. The St. Louis water intakes on the Missouri and Mississippi Rivers were selected for studying the relationship between sediment and water treatment.

Work Group Members

The Erosion and Sediment Work Group was comprised of an informal gathering of specialists from a multiple of federal and state agencies and institutions. Members of the work group participating at the completion of the study are shown in the following list. Names of additional participants in the study are shown in parentheses.

U.S. Geological Survey	
Missouri	Wayne Berkas (Don Coffin) (Horace Jeffery)
Illinois	Tim Lazaro (Doug Glysson)
University of Missouri at Rolla, MO	(Dr. Glendon Stevens) Dr. Charles Morris
Science Education Administration, Federal Research	Allan Hjelmfelt (Robert Piest)
U.S. Army Corps of Engineers	Claude Strauser
Soil Conservation Service	
Illinois	Keith Donelson
Missouri	Vernon Finney (Joe Marshall)

Figure 1 -- Hydrologic Units, GREAT III, Erosion and Sediment Work Group Study Area, Illinois and Missouri.



II. GAGE LOCATIONS AND DESCRIPTIONS

The Erosion and Sediment Work Group gathered available stream sedimentation and flow data within the GREAT III area and funded the establishment of sediment gaging at Alton, Ill., Chester, Ill., and Thebes, Ill., on the Mississippi River; at Monroe City and New London, Missouri, on the Salt River; at Eureka, Mo., on the Meramec River; at Valley City, Ill., on the Illinois River; at Murphysboro, Ill., on the Big Muddy River; at Venedy Station, Ill., on the Kaskaskia River; and on Saline Creek in Missouri. This chapter gives gage locations and summarizes data collection, procedures, and analyses for each gage. Trend analyses were made on data collected from the Mississippi River at Hannibal, Missouri; and the Missouri River at Hermann, Missouri. The summaries for the Hannibal, Hermann, and St. Louis stations are modified from reference 1. Figure 2 is a river mile schematic of the inventoried stations. Table 1 summarizes sediment and discharge data for the inventoried stations. Station summaries are presented in downstream order starting with the uppermost station at Hannibal, Missouri. Station locations are identified on location figures by triangles. The abbreviation OWDC under station identification stands for Office Water Data Coordination.

Figure 2 -- Study Area Schematic, GREAT III, Erosion and Sediment Work Group, Illinois and Missouri.

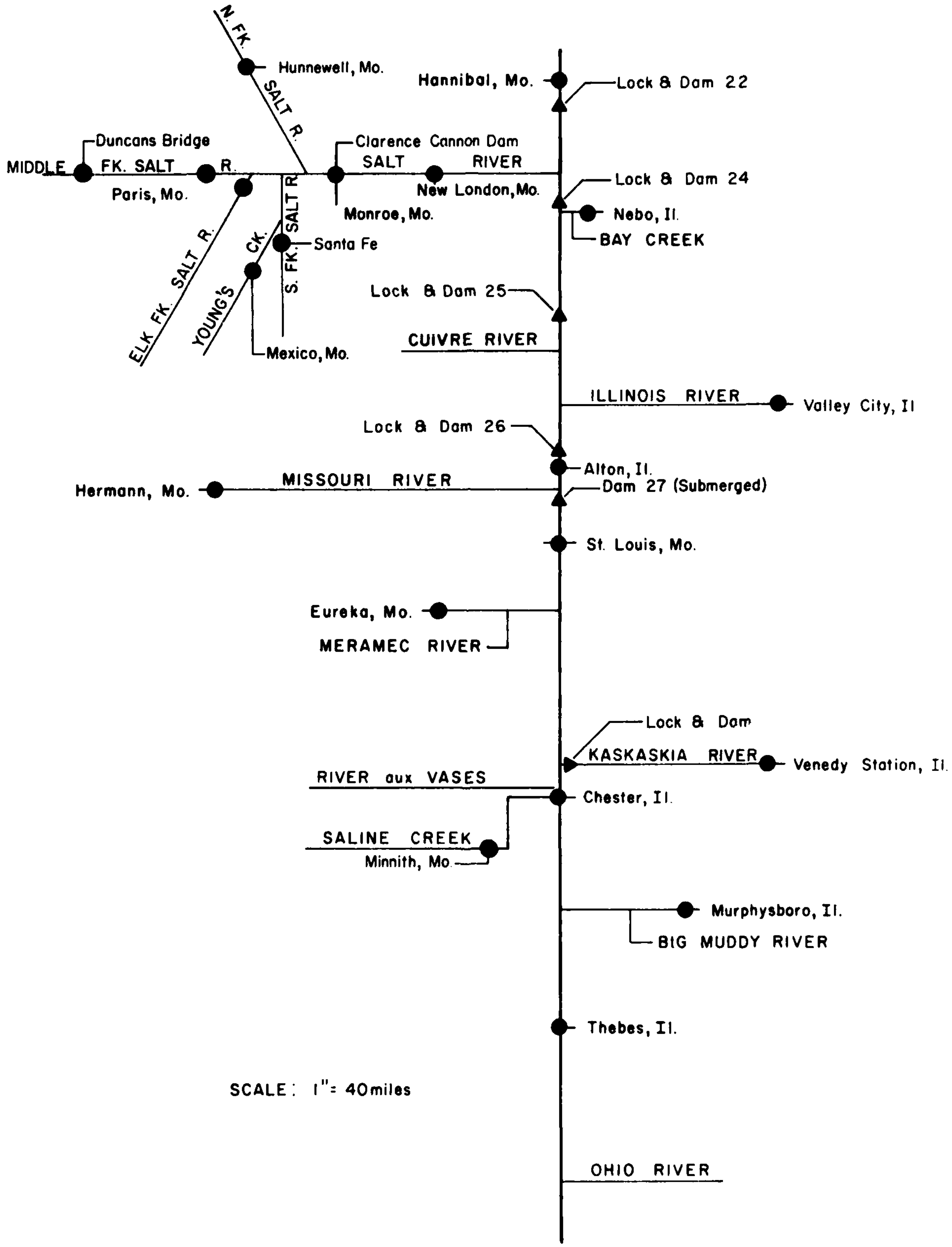


TABLE 1 -- Suspended Sediment Discharge and Water Discharge Summary for Inventoried Stations Within the GREAT III Study Area

WATERWAY	Gage Locations	Drainage Area Mi.^{2}	WATER DISCHARGE Record Period	WATER DISCHARGE Maximum CFS	WATER DISCHARGE Minimum CFS	WATER DISCHARGE Mean CFS	SUSPENDED SEDIMENT DISCHARGE Record Period	SUSPENDED SEDIMENT DISCHARGE Maximum tons/day	SUSPENDED SEDIMENT DISCHARGE Minimum tons/day	SUSPENDED SEDIMENT DISCHARGE Mean tons/day
Mississippi River	Hannibal, MO	137,300	1878-1981	478,000	* 5,000	*71,000	10/43-9/78	1,160,000	200	73,500
Salt River	Hunnewell, MO	626	10/30-9/40 10/79-9/81	22,600	0.00	352	7/80-9/81	30,900	0.03	1,342
Elk Fork Salt River	Paris, MO	262	4/30-10/54 8/80-9/81	20,600 13,600	0.00 0.06	185 547	--- 8/81-9/81	--- 3,860	--- 0.00	--- N.C.
Goodwater Creek	Centralia, MO	27.9	4/71-12/81	3,745	0.00	2.6	2/79-3/81	7,000	0.00	13.5
Youngs Creek	Mexico, MO	67.4	8/36-9/69 7/80-9/81	8,120	0.00	44	7/80-9/81	16,900	0.00	242
Middle Fork Salt River	Duncans Bridge, MO	200	11/80-9/81	7,820	0.15	258	11/80-9/81	10,000	0.00	340
Middle Fork Salt River	Paris, MO	356	10/39-9/81	45,000	0.00	236	8/80-9/81	25,400	0.01	806
South Fork Salt River	Santa Fe, MO	298	10/39-9/79	28,800	0.00	188	11/80-9/81	46,700	0.00	757
Salt River	Monroe City, MO	63.5	10/39-9/80	102,000	0.00	1,490	10/41-10/66	---	---	---
Salt River	New London, MO	2,480	2/22-9/81	107,000	0.00	1,660	7/80-9/81	143,000	0.45	-
Bay Creek	Nebo, IL	176	10/39-9/80	13,600	0.00	96	10/39-9/80	649,000	0	826

* Computed from rating curve for Lock and Dam 22, Saverton, MO.

TABLE 1 -- Continued

WATERWAY	Gage Locations	Drainage Area Mi.^{2}	WATER DISCHARGE Record Period	Maximum CFS	Minimum CFS	Mean CFS	SUSPENDED SEDIMENT DISCHARGE Record Period	Maximum tons/day	Minimum tons/day	Mean tons/day
Illinois River	Valley City, IL	26,564	10/38-9/80	123,000	1,740	21,300	10/38-9/80	410,000	1,220	28,103
Mississippi River	Alton, IL	171,500	10/27-9/81	535,000	7,960	99,000	10/80-9/81	1,120,000	1,290	118,000
Missouri River	Hermann, MO	524,200	1897-1955	676,000	11,000	79,500	1949-1955	8,340,000	10,120	663,200
Missouri River	Hermann, MO	524,200	1956-1969	401,000	6,210	70,800	1956-1969	4,547,000	503	270,100
Missouri River	Hermann, MO	524,200	10/65-9/80	500,000	13,900	83,500	10/65-9/80	2,387,000	1,000	254,000
Mississippi River	St. Louis, MO	697,000	1866-1981	1,019,000	18,000	151,900	4/48-9/81	7,010,000	2,800	366,000
Meramec River	Eureka, MO	3,788	10/21-9/81	120,000	196	3,000	2/69-9/70 8/80-9/81	175,000	3.2	2,170
Kaskaskia River	Venedy Sta., IL	4,393	10/69-9/80	41,800	54	3,484	10/69-9/80	19,700	1.9	970
Saline Creek	Minnith, MO	82.6	6/80-9/81	6,700	3	36	9/80-9/81	772	0.03	9.8
Mississippi River	Chester, IL	708,600	10/27-9/81	886,000	30,000	183,200	5/80-9/81	2,410,000	3,580	-
Big Muddy River	Murphysboro, IL	2,169	10/31-9/80	33,300	4,400	1,778	10/31-9/80	8,430	0.62	378
Mississippi	Thebes,									

Mississippi River at Hannibal, Missouri

SOURCE: Modified from Reference 1

Station Identification

OWDC No.: 54604

Agency Station No.: None, only name is used by agency

Latitude/Longitude: 394324/912149

Agency reporting to OWDC: CE

River mile: 309.2 (Mile 0 is at the confluence of the Mississippi and Ohio Rivers; established by the CE in 1930.)

Drainage area: 137,300 square miles

Site Description

From 1943 through 1965, the sediment sample collection station was on the now abandoned Wabash Railroad bridge approximately 2 miles downstream (about mile 307) from its present position. Since 1965, the station has been near the right (or Missouri) bank of the Mississippi River on the Mark Twain Highway Bridge (U.S. Highway 36), which joins Hannibal, Missouri, and East Hannibal, Illinois (Figure 3). It is 0.6 mile downstream from the Norfolk and Western Railway bridge and 15.7 miles downstream from Lock and Dam No. 21. Between the sampling station and Lock and Dam No. 21 are a series of submerged wing dams, submerged and upper bank revetment, and artificial levees along both banks. There are a number of scattered commercial docks and recreational sites upstream from the sampling station as well as the Hannibal urban area. Limestone bedrock is exposed in the channel, but some sand generally accumulates in the deepest portions. The channel gradient is 0.5 ft/mile. The discharges of record (1878-1981) are: maximum - 478,000 cfs; and minimum - 5,000 cfs. The mean discharge is 71,000 cfs. Flows are influenced to some degree by backwater from Lock and Dam No. 22 (mile 301.2). The calculated daily sediment discharge of record (1943-1978) are: maximum - 1,160,000 tons/day; mean - 73,500 tons/day; and minimum - 200 tons/day. The calculated annual sediment loads of record (1943-1978) are: maximum - 84,580,000 tons, mean - 26,830,000 tons/year, and minimum - 3,700,000 tons.

Station Chronological Record

This station was established in 1943 by the CE Rock Island District (RID) to be representative of the farthest downstream reach of the Mississippi River under its jurisdiction. The location was chosen because of its proximity to a station with a long-term gaging record. Sample collection and data reduction are the responsibility of the RID. Sample laboratory analysis was handled by the RID until 1967; since 1967, the USGS Sedimentation Laboratory at Iowa City, Iowa, has analyzed the sediment samples.

Sample Data Collection Procedures

Depth-integrated, suspended sediment samples, as well as temperatures and unofficial gage-height readings, have been collected daily (except on those days when the ice cover was too thick for sampling) by USGS-paid observers. Prior to 1950, a device developed by the RID, known as the "Rock Island Sampler," was used (Reference 2). This was a nozzle-fed, bottleless sampler. When the cavity of the sampler was filled, the sampler was agitated and samples were poured into bottles. Since sediment particles always remained inside the sampler, the results obtained were unrealiable; a factor of 10 percent was always added to suspended-sediment concentrations obtained with the Rock Island Sampler. Since 1950, the US D-49 sampler has been used; Reference 3 contains detailed instructions for operation of this sampler.

The gaging record in the vicinity of Hannibal, Missouri, began in 1871 when intermittent measurements were taken from a stone gage (i.e., a gage with notches carved into the limestone formation exposed at the river). Daily gage readings and the discharge record began in 1878. The following tabulation lists the gaging and recording devices used in the vicinity of Hannibal during the period of record and the agencies responsible for collecting these data:

Period	Locality	Device Used
	RID	
1871 - 1913	Wabash Railroad bridge (mile 307)	Stone gage
1913 - June 1967	Center pivot pier of Wabash Railroad bridge (mile 307)	Staff gage
22 July 1938 - September 1981	Lock and Dam No. 22	Stevens Type F continuous water-stage recorder
June 1967 - September 1981	Norfolk and Western Railway bridge (mile 309.8)	Enameled staff gage
	U.S. Weather Bureau (now National Weather Service)	
April 1892 - 1913	Wabash Railroad bridge (mile 307)	Stone gage
1913 - 12 June 1914	Center pivot pier of Wabash Railroad bridge (mile 307)	Staff gage
12 June 1914 - 28 June 1934	Center pivot pier of Wabash Railroad bridge (mile 307)	Marvin automatic River gage

Period	Locality	Device Used
	U.S. Weather Bureau (now National Weather Service)	
28 June 1934 - 7 April 1966	Center pivot pier of Wabash Railroad bridge (mile 307)	Type A wire-weight and vertical enameled staff gages
7 April 1966 - September 1981	Hannibal City waterworks (mile 309.8)	Bristol resistance gage

Flows over 143,000 cfs are computed using the rating curve developed for the railway bridge; flows of 143,000 cfs and less are computed using the rating curve developed for Lock and Dam No. 22 (mile 301.2).

Laboratory Sample Analysis

The RID operated its own sediment laboratory and analyzed samples until 1967. Since 1967, the USGS laboratory in Iowa City, Iowa, has handled analysis of sediment samples. The procedures employed by both agencies for running suspended sediment concentrations were identical. The bottom-withdrawal-tube method was used for obtaining particle-size distribution data by both agencies prior to 1971, and since 1971, the USGS has used the visual-accumulation tube for this purpose. All laboratory procedures are discussed in Reference 4.

Data Reduction Procedures

Until 1950, when the Rock Island Sampler was in use, 10 percent was added to the suspended sediment concentration values, but this adjustment was eliminated in 1950. Prior to 1968, all computations of suspended sediment load were performed manually, and no attempt was made to interpolate missing sediment concentration values. Since 1968, the suspended sediment concentration data and daily average flow rates have been punched into computer cards and input to a computer program (documented in reference 5), which computes daily suspended sediment loads. This program is capable of handling interpolation of up to 29 consecutive days of missing suspended sediment concentration records, provided discharges were obtained on those days. The program, however, will not attempt to interpolate suspended sediment concentrations for more than 29 consecutive days of missing records.

Data Reporting Procedures

Neither the daily streamflow nor the daily suspended sediment load values are published. The RID, however, is attempting to obtain computer printouts (for in-house use at present) of its data at least as far back as 1968. A sample printout is shown as Table 2. The University of Missouri at Rolla has stored mean daily flow records and suspended sediment concentration measurements in its computer storage banks for water years 1944-1960, 1962-1964, and 1967-1978. Not every month is available for these years. Sixty-three grain size analyses of suspended sediment are also available for the time frame September 1943 to June 1968. Grain size analyses are no longer done.

General Information

Information concerning this sediment sample collection station can be obtained from: District Engineer, U.S. Army Engineer District, Rock Island, Hydraulics Section, Clock Tower Building, Rock Island, Illinois 61201.

Figure 3 -- Sediment Sample Collection Location for Mississippi River at Hannibal, Missouri

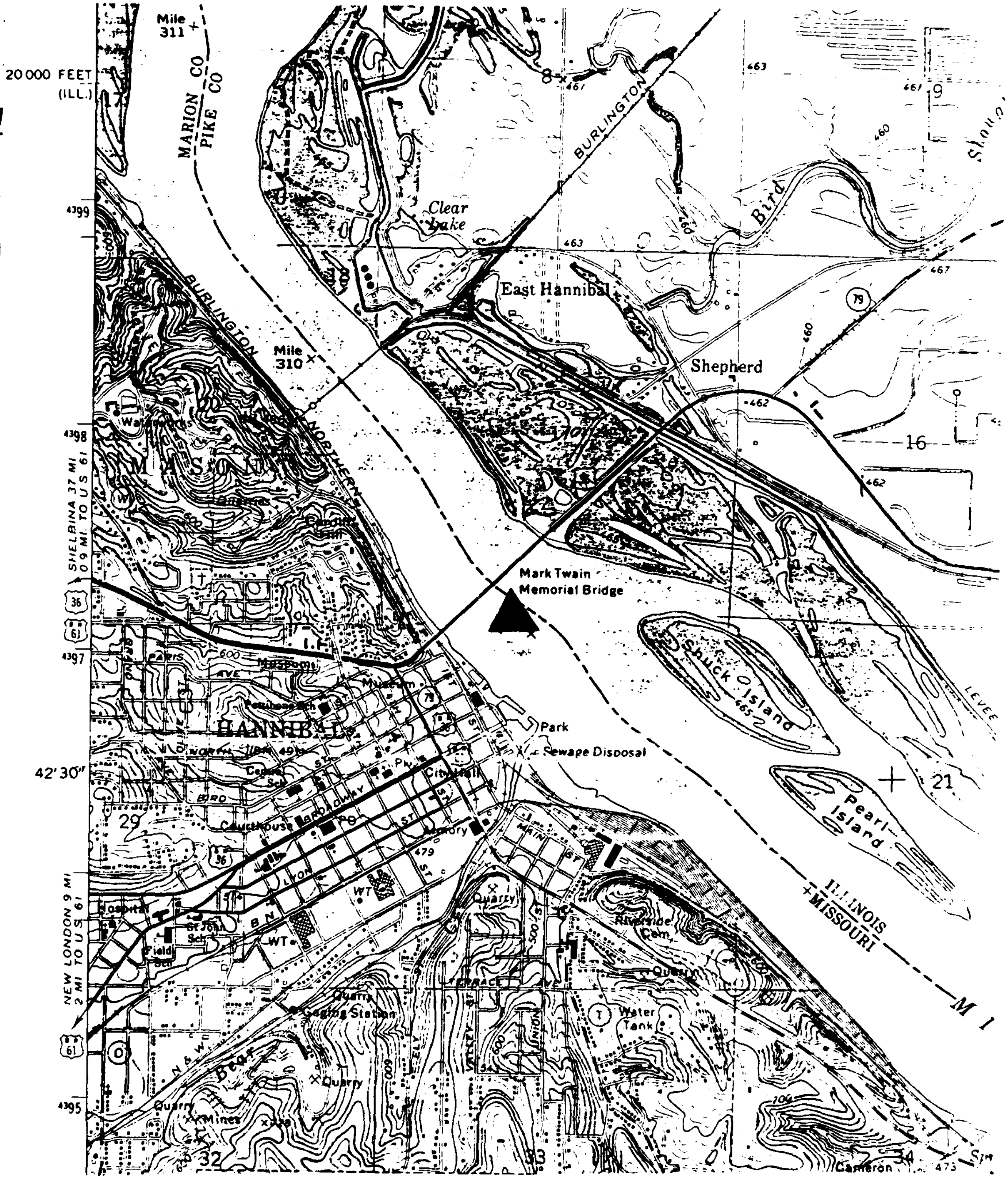


TABLE 2 -- Example of Sediment Data for Hannibal, Missouri
(printout provided by U.S. Army Engineer District, Rock Island)

MISSISSIPPI RIVER AT HANNIBAL MO. 18 FEB 1976 STIMAN

DAILY SUSPENDED SEDIMENT LOAD WATER YEAR 1974

DAY	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.
1	98522.	61492.	7286.	9849.	55641.	29775.	14635.	170299.	242063.	300830.	29612.	5341.
2	91384.	48947.	11291.	9233.	51978.	37568.	14739.	81156.	252809.	280437.	25092.	36427.
3	96886.	46048.	12207.	7499.	37341.	75392.	15677.	156810.	303263.	254856.	23620.	106088.
4	52812.	42980.	11127.	5135.	29921.	59781.	11228.	141958.	372559.	238985.	17298.	56545.
5	235522.	34654.	22501.	5840.	24396.	66675.	152934.	82768.	104340.	238858.	26295.	38313.
6	186485.	30783.	24046.	24970.	21278.	74695.	145775.	132163.	32247.	215243.	26304.	48389.
7	59855.	17362.	21776.	24770.	16124.	88812.	25800.	190919.	17515.	192585.	7836.	50791.
8	57429.	29229.	24272.	27960.	17338.	119132.	51913.	201375.	66120.	168469.	19443.	26876.
9	178928.	17073.	23360.	26360.	15014.	112841.	212110.	108881.	113712.	125188.	26250.	21610.
10	209046.	15062.	17355.	26440.	15565.	231178.	188311.	21443.	26018.	131513.	22619.	11021.
11	204268.	15617.	13471.	27471.	15234.	187062.	71433.	22382.	69494.	134421.	25701.	10263.
12	212495.	14666.	10695.	31759.	26715.	34772.	37419.	140684.	107793.	137965.	47058.	9480.
13	343082.	17920.	11780.	33669.	26615.	32392.	23152.	391204.	95346.	123428.	38441.	9908.
14	277941.	13563.	13531.	31795.	24526.	37180.	29956.	358203.	49917.	103083.	24161.	7895.
15	237329.	14557.	10935.	31592.	21371.	73315.	32189.	154502.	61709.	145786.	28912.	15568.
16	119675.	13328.	7845.	32623.	22348.	70422.	60877.	111489.	65585.	138856.	11003.	37743.
17	138305.	8158.	7005.	32417.	24330.	40277.	142438.	127373.	88139.	62258.	29789.	14521.
18	190094.	8776.	12701.	35991.	25392.	28784.	217711.	178349.	177537.	52526.	26174.	2446.
19	161812.	9974.	10892.	36411.	26827.	21875.	261883.	256663.	187133.	51067.	15746.	2466.
20	234291.	10067.	7145.	35529.	23414.	[illegible]	210883.	764010.	185034.	34262.	15709.	12350.
21	234330.	7390.	12576.	30273.	21464.	136189.	87700.	842878.	194095.	33565.	16279.	28947.
22	127911.	8237.	10901.	51290.	27277.	140465.	103245.	345307.	219399.	34781.	20941.	12499.
23	109616.	8727.	10827.	41241.	27543.	91854.	79199.	249495.	211471.	73384.	21239.	4351.
24	103669.	8050.	11548.	23953.	29952.	78768.	74059.	206605.	218465.	67100.	32443.	4571.
25	115511.	8559.	13598.	21793.	33032.	64616.	82246.	274645.	246791.	36462.	44138.	3527.
26	93772.	9710.	16414.	18612.	30647.	55549.	101150.	269469.	233030.	19521.	28367.	585.
27	92490.	13706.	10716.	27015.	27240.	54779.	122794.	285701.	94421.	18365.	15093.	548.
28	83076.	14282.	10739.	21786.	25729.	44359.	144245.	278265.	296644.	21116.	2693.	2815.
29	75928.	15708.	9583.	19431.		27446.	152609.	183569.	306450.	23054.	849.	6696.
30	73900.	13098.	12749.	19011.		12197.	217411.	119399.	299939.	32502.	1330.	19763.
31	64240.		12221.	26191.		13866.		206537.		25605.	2178.	
	4560694.	563983.	418225.	797910.	738772.	2194714.	3110744.	7050551.	4967474.	3516297.	672815.	608664.

YEARLY TOTAL = 29209942. TONS

TOTAL YEARLY DISCHARGE = 91231519. ACRE FEET

North Fork Salt River near Hunnewell, Missouri

SOURCE: U.S. Geological Survey Files

Station Identification

OWDC No.: 21679

Agency Station No.: 05503500

Latitude/Longitude: 394005/915411

Agency reporting to OWDC: U.S. Geological Survey

Drainage area: 626 square miles

River mile: 105.8 miles from the confluence of the Salt River with the Mississippi River. The Salt River is at river mile 284.2 (mile 0 is at the confluence of the Mississippi River and Ohio River; established by the Corps of Engineers during 1930).

Site Description

The station is located on the right bank downstream from State Highway 36 bridge, 2 miles west of Hunnewell, Missouri (Figure 4). The Salt River at this location is now called North Fork Salt River. The water-level instrumentation is in a metal shelter on the right bank. The sediment sampler is attached to the downstream side of the bridge. The streambed is composed of sand and silt and has a median particle size of 0.5 millimeters in diameter. Discharges of record (April 1930 to September 1940) are: maximum - 22,600 cfs; minimum - no flow. The suspended sediment loads of record (July 1980 to September 1981) are: maximum - 30,900 tons/day (1981); mean - 1,342 tons/day; minimum - 0.03 tons/day (1980).

Station Chronological Record

This station was established during April 1930, as a daily discharge record station by the U.S. Geological Survey. On September 30, 1940, the station was discontinued. During June 1967, the U.S. Army Corps of Engineers, St. Louis District, reestablished the station and published mean daily discharge records. During October 1979, the U.S. Geological Survey resumed the operation of the station. At this time, the gage was moved from the old bridge to a new one 50 feet upstream. On July 19, 1980, a sediment sampler was attached to the downstream side of the bridge and daily samples were collected by an observer.

Sample and Data Collection Procedures

Sampling for suspended sediment began July 19, 1980, by U.S. Geological Survey personnel, according to the procedures discussed in reference 6. Daily depth-integrated samples are collected from a stationary sampling station using a US D-74. Once a month the complete cross section is sampled by the equal-transit-

rate (ETR) method (equal spacing between verticals) discussed in reference 6 using a US P-61, US D-74, or a US DH-48. The monthly samples are used, along with the daily single vertical samples and daily river stage, to obtain an average daily suspended sediment concentration (reference 16). An explanation of the samplers used may be found in reference 21.

Laboratory Sample Analysis

Suspended sediment concentration analyses are performed by the U.S. Geological Survey laboratory at Rolla, Missouri, according to procedures discussed in reference 22.

Data Reduction Procedures

The sediment records will be computed using standard U.S. Geological Survey methods as discussed in reference 16. The complete river-stage hydrograph is plotted, the suspended sediment data reevaluated and plotted with the stage hydrograph, the suspended sediment curve is drawn from plotted points using the stage hydrograph as a guide, then the daily suspended sediment values are taken from this graph and stored in the computer. The daily sediment discharge is calculated from the daily suspended sediment and daily discharge values.

Data Reporting Procedures

Daily and monthly sediment discharge and daily suspended sediment concentrations will be published in "Water Resources for Missouri" for each water year.

General Information

Information concerning this sediment sample-collection station can be obtained from: District Chief, U.S. Geological Survey, Water Resources Division, Mail Stop 200, 1400 Independence Road, Rolla, Missouri 65401.

Figure 4 -- Sediment Sample Collection Location for Salt River near Hunnewell, Missouri

<u>Middle Fork Salt River at Duncans Bridge, Missouri</u>

SOURCE: U.S. Geological Survey Files

Station Identification

OWDC No: None assigned

Agency Station No: 05506190

Latitude/Longitude: 393425/921554

Agency reporting to OWDC: U.S. Geological Survey

Drainage area: 200 square miles

River mile: 43.5 miles upstream from the confluence with Elk Fork Salt River, and 135.5 miles upstream from the confluence of the Salt and Mississippi Rivers. The Salt River is at river mile 284.2 (mile 0 is at the confluence of the Mississippi and Ohio River; established by the Corps of Engineers in 1930).

Site Description

This station is located on the downstream side of the highway J bridge at Duncans Bridge, Missouri (Figure 5). The water-level instrumentation in a metal shelter on left side of the bridge looking downstream. A sediment sampler is attached to the downstream side of the bridge. The streambed consists of silt and gravel. The right bank overflows at about 19.[illegible] feet gage height and the left bank overflow at about 17.0 feet gage height. Overflow on the road, approximately 50 feet to the right of the bridge, occurs at about 22.3 feet gage height.

Station Chronological Record

This station was established on August 29, 1980, by the U.S. Geological Survey to collect daily discharge and sediment data.

Sample and Data Collection Procedures

Suspended sediment sampling is performed by U.S. Geological Survey personnel, according to the procedures discussed in reference 6. Daily depth-integrated samples are collected from a stationary sampling station using a US D-74. Once a month the complete cross section is sampled by the equal-transit-rate (ETR) method (equal spacing between verticals) discussed in reference 6 using a US P-61, US D-74, or a US DH-48. The monthly samples are used, along with the daily single vertical samples and daily river stage, to obtain an average daily suspended sediment concentration (reference 16). An explanation of the samplers used may be found in reference 21.

Laboratory Sample Analysis

Suspended sediment concentration analyses are performed by the U.S. Geological Survey laboratory at Rolla, Missouri, according to procedures discussed in reference 22.

Data Reduction Procedures

The sediment records will be computed using standard U.S. Geological Survey methods as discussed in reference 16. The complete river-stage hydrograph is plotted, the suspended sediment data reevaluated and plotted with the stage hydrograph, the suspended sediment curve is drawn from plotted points using the stage hydrograph as a guide, then the daily suspended sediment values are taken from this graph and stored in the computer. The daily sediment discharge is calculated from the daily suspended sediment and daily discharge values.

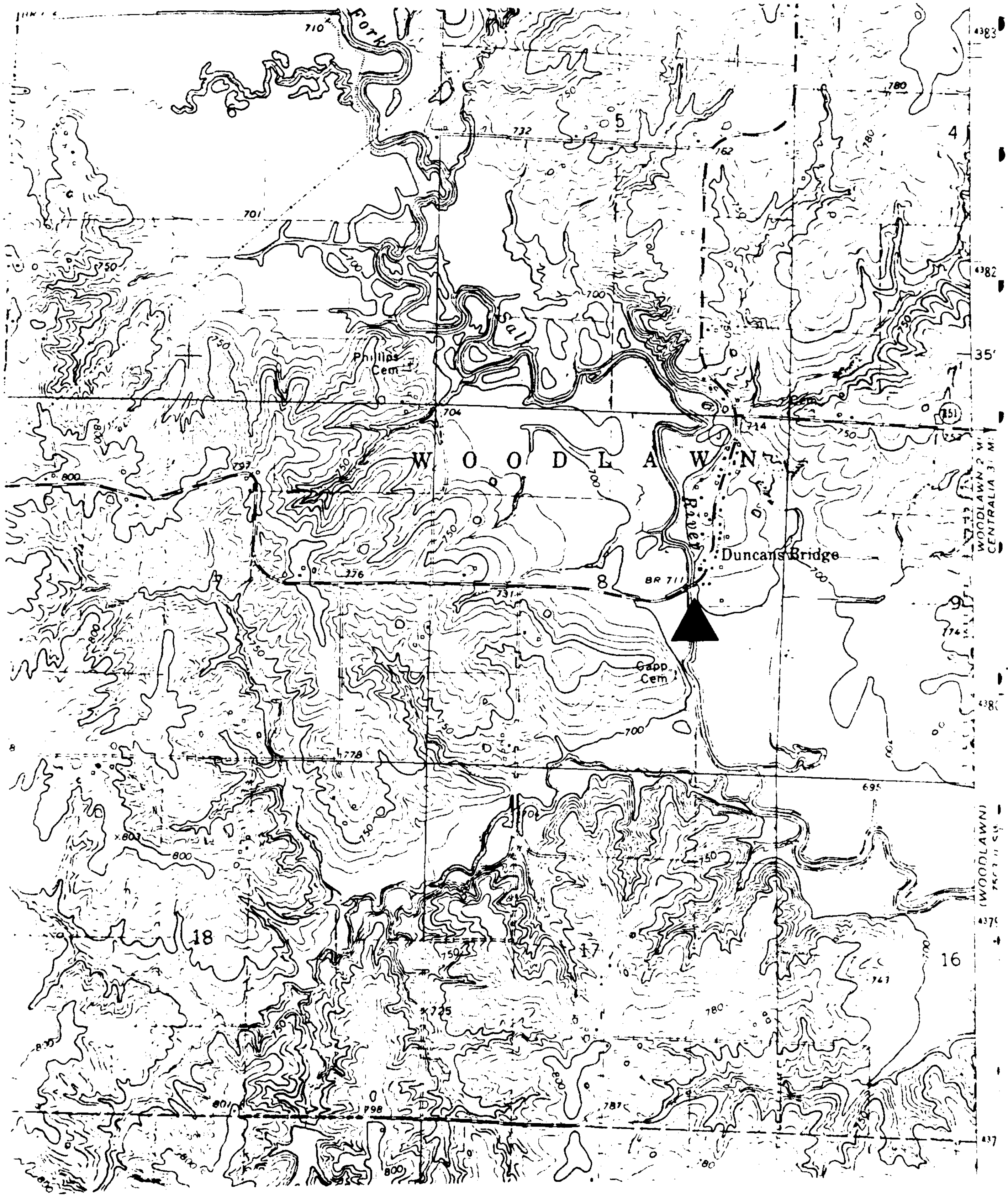
Data Reporting Procedures

Daily and monthly sediment discharge and daily suspended sediment concentrations will be published in "Water Resources for Missouri" for each water year.

General Information

Information concerning this sediment sample-collection station can be obtained from: District Chief, U.S. Geological Survey, Water Resources Division, Mail Stop 200, 1400 Independence Road, Rolla, Missouri 65401.

Figure 5 -- Sediment Sample Collection Location for Middle Fork Salt River at Duncans Bridge, Missouri.



Middle Fork Salt River at Paris, Missouri

SOURCE: U.S. Geological Survey Files

Station Identification

OWDC No.: 07366

Agency Station No.: 05506500

Latitude/Longitude: 392905/915950

Agency reporting to OWDC: U.S. Geological Survey

Drainage area: 356 square miles

River mile: 12.5 miles upstream from the confluence with Elk Fork Salt River, and 104.5 miles upstream from the confluence of the Salt and Mississippi Rivers. The Salt River is at river mile 284.2 (mile 0 is at the confluence of the Mississippi and Ohio Rivers; established by the Corps of Engineers in 1930).

Site Description

The station is located at a bridge crossing the Middle Fork Salt River on East Madison Street in Paris, Missouri, about 600 feet downstream from Wabash Railroad bridge (Figure 6). The instrumentation for the gage is housed in a metal shelter at the right upstream end of the bridge. The right bank is high with overflow about 28.7 feet gage height, and the left bank is heavily wooded with overflow above 15 feet gage height. The streambed is mainly composed of sands and silts and has a median particle size of 0.5 millimeter in diameter. Discharges of record (October 1939 to September 1979) are: maximum - 45,000 cfs; minimum - no flow. The suspended sediment loads of record (August 1980 to September 1981) are: maximum - 25,400 tons/day, mean - 806 tons/day, and minimum - 0.01 tons/day.

Station Chronological Record

This station was established during October 1939 to provide daily discharge values. During October 1980, suspended sediment sampling was started for the purpose of obtaining daily suspended sediment data. At this time, a suspended sediment sampler was attached to the upstream side of the bridge and daily samples were obtained by an observer.

Sample and Data Collection Procedures

Sampling for suspended sediment began August 6, 1980, by U.S. Geological Survey personnel, according to the procedures discussed in reference 6. Daily depth-integrated samples are collected from a stationary sampling station using a US D-74. Once a month the complete cross section is sampled by the equal-transit-rate (ETR) method (equal spacing between verticals) discussed in reference 6

using a US P-61, US D-74, or a US DH-48. The monthly samples are used, along with the daily single vertical samples and daily river stage, to obtain an average daily suspended-sediment concentration (reference 16). An explanation of the samplers used may be found in reference 21.

Laboratory Sample Analysis

Suspended sediment concentration analyses are performed by the U.S. Geological Survey laboratory at Rolla, Missouri, according to procedures discussed in reference 22.

Data Reduction Procedures

The sediment records will be computed using standard U.S. Geological Survey methods as discussed in reference 16. The complete river-stage hydrograph is plotted, the suspended sediment data are evaluated and plotted with the stage hydrograph, the suspended sediment curve is drawn from the plotted points using the stage hydrograph as a guide, then the daily suspended sediment values are taken from this graph and stored in the computer. The daily sediment discharge is calculated from the daily suspended sediment and daily discharge values.

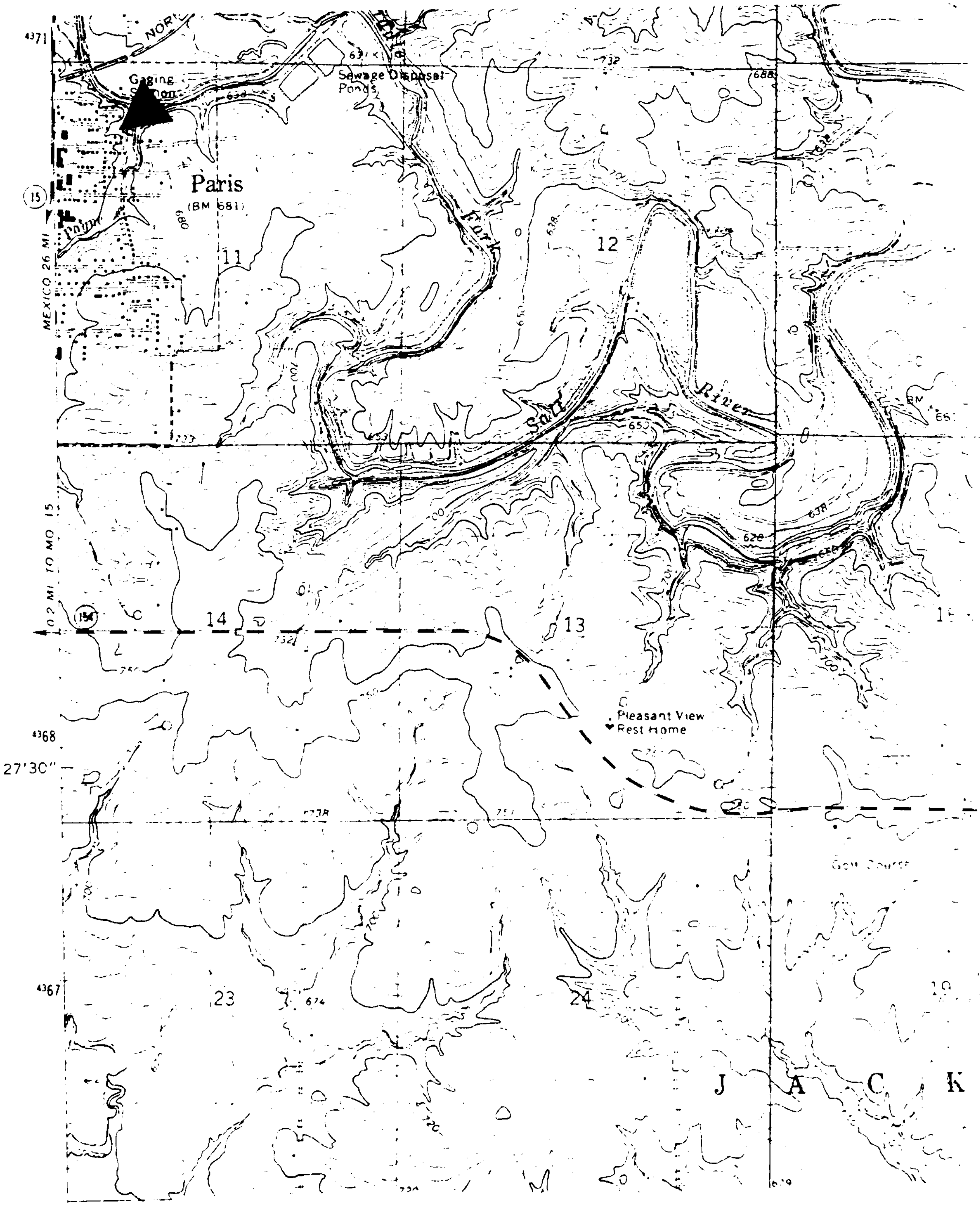
Data Reporting Procedures

Daily and monthly sediment discharge and daily suspended sediment concentrations will be published in "Water Resources Data for Missouri" for each water year.

General Information

Information concerning this sediment sample-collection station can be obtained from: District Chief, U.S. Geological Survey, Water Resources Division, Mail Stop 200, 1400 Independence Road, Rolla, MO 65401.

Figure 6 -- Sediment Sample Collection Location for Middle Fork Salt River at Paris, Missouri



Elk Fork Salt River near Paris, Missouri

SOURCE: U.S. Geological Survey Files

Station Identification

OWDC No.: None assigned

Agency Station No.: 05507000

Latitude/Longitude: 392625/920005

Agency reporting to OWDC: U.S. Geological Survey

Drainage area: 262 square miles

River mile: 99.5 miles upstream from the confluence of the Salt River with the Mississippi River. The Salt River is at river mile 284.2 (mile 0 is at the confluence of the Mississippi and Ohio Rivers; established by the Corps of Engineers during 1930).

Site Description

The station is located on State Highway 14 crossing the Elk Fork Salt River, 2.3 miles south of Paris, Missouri (Figure 7). The water-level instrumentation is in a metal shelter at the left downstream end of the bridge. The sediment sampler is attached to the downstream side of the bridge. The streambed is composed of sands and silts and has a median particle size of 0.5 millimeter in diameter. Discharges of record (April 1930 to October 1954) are: maximum - 20,600 cfs; minimum - no flow.

Station Chronological Record

This station was established by the U.S. Geological Survey during April 1930 as a daily discharge record station. On October 3, 1954, the station was discontinued. During August 1980, the station was reestablished as a daily discharge and suspended sediment record station.

Sample and Data Collection Procedures

Sampling for suspended sediment began August 7, 1980, by U.S. Geological Survey personnel, according to the procedures discussed in reference 6. Daily depth-integrated samples are collected from a stationary sampling station using a US D-74. Once a month the complete cross section is sampled by the equal-transit-rate (ETR) method (equal spacing between verticals) discussed in reference 6 using a US P-61, US D-74, or a US DH-48. The monthly samples are used, along with the daily single vertical samples and daily river stage, to obtain an average daily suspended sediment concentration (reference 16). An explanation of the samplers may be found in reference 21.

Laboratory Sample Analysis

Suspended sediment concentration analyses are performed by the U.S. Geological Survey laboratory at Rolla, Missouri, according to procedures discussed in reference 22.

Data Reduction Procedures

The sediment records will be computed using standard U.S. Geological Survey methods as discussed in reference 16. The complete river stage hydrograph is plotted, the suspended sediment data are evaluated and plotted with the stage hydrograph, the suspended sediment curve is drawn from the plotted points using the stage hydrograph as a guide, then the daily suspended sediment values are taken from this graph and stored in the computer. The daily sediment discharge is calculated from the daily suspended sediment and daily discharge values.

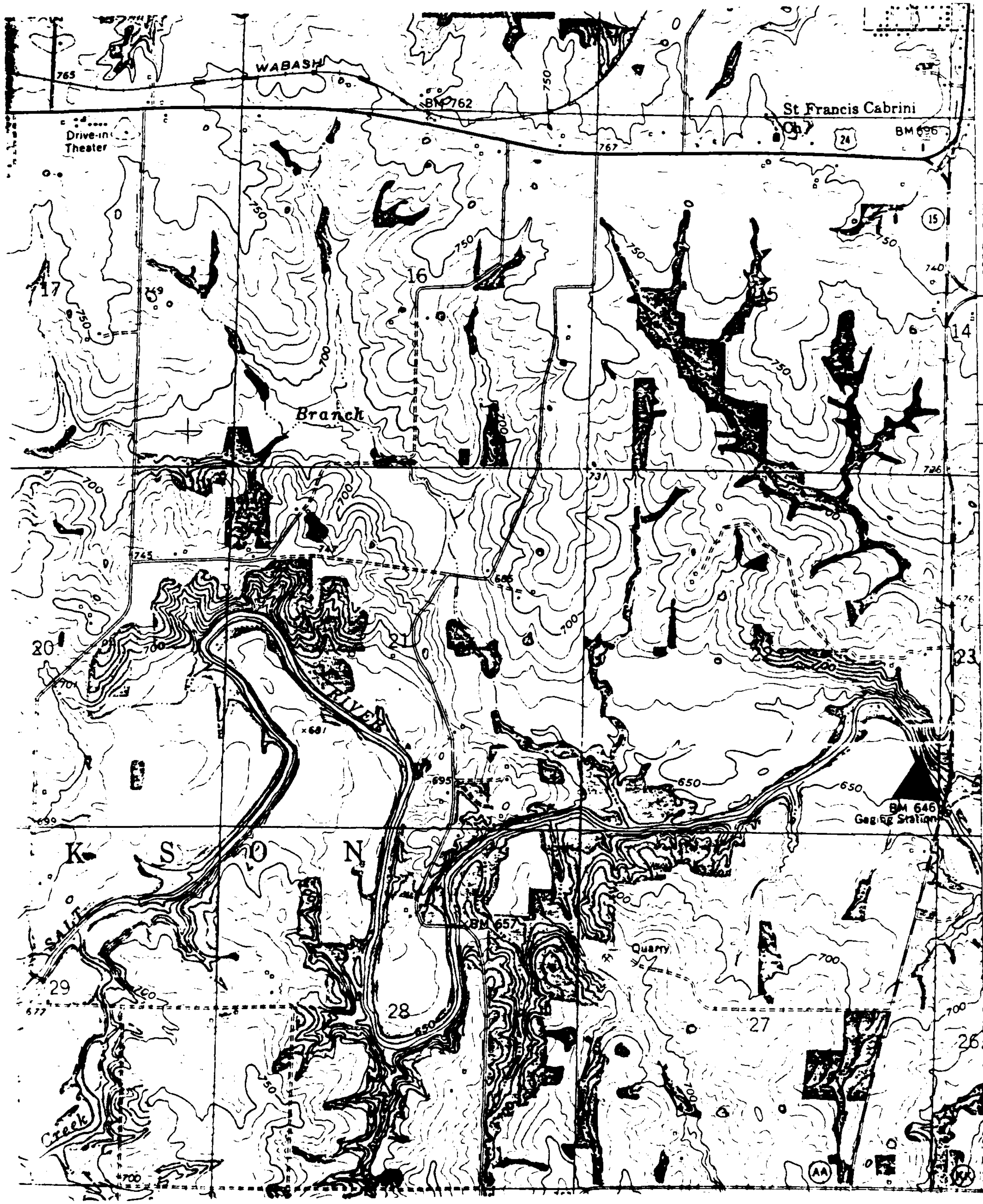
Data Reporting Procedures

Daily and monthly sediment discharge and daily suspended sediment will be published in "Water Resources Data for Missouri" for each water year.

General Information

Information concerning this sediment sample-collection station can be obtained from: District Chief, U.S. Geological Survey, Water Resources Division, Mail Stop 200, 1400 Independence Road, Rolla, Missouri 65401.

Figure 7 -- Sediment Sample Collection Location for Elk Fork Salt River near Paris, Missouri



Goodwater Creek near Centralia, Missouri

SOURCE: From USDA AGricultural Research Service Files

Station Identification

OWDC No.: None assigned

Agency Station Number: Centralia W-1

Latitude/Longitude: 391814/920308

Agency reporting to OWDC: Agricultural Research Service

Drainage area: 27.9 square miles

River mile: 118 miles above confluence with Salt River.

Site Description

The station is located at Audrain County, Missouri road bridge near Goodwater School about 7 miles northeast of Centralia, Missouri (Figure 8). The water-level instrumentation is on the downstream side of the bridge above a concrete low flow control broadcrested V-notch weir with a 2-foot notch and 5:1 side walls. A footbridge across the channel about 500 feet downstream of this weir is used for flow velocity measurements and sediment sampling. The channel curves above the road bridge but is straight for several hundred feet below the bridge. Trees are scattered along the banks above the gaging station and below the footbridge. The right bank overflows at a stage of 4.7 feet. The left bank overflows at a stage of 5.7 feet. The gravel road is subject to overflow at a stage of 6.3 feet. The channel gradient is 4.8 feet per mile. Discharges of record (April 1971 to January 1982) are: maximum -3,745 cfs; minimum - no flow. Not enough data are available for estimating sediment loads for all flow events.

Station Chronological Record

Continuous stage records were begun April 1971. Suspended sediment samples were obtained by observation on weekly intervals and during some flow events beginning 1979.

Sample and Data Collection Procedures

Suspended sediment samples collected manually by Agricultural Research Service personnel with depth integrating US DH-48 sampler on carriage which traverses the footbridge. During extreme flow when footbridge was inaccessible, hand-dip samples were taken at road bridge. During low-flow hand-dip samples were taken at weir notch.

Laboratory Sample Analysis

Suspended sediment concentration analyses are performed by Agricultural Research Service, Watershed Research Unit, Columbia, Missouri according to procedures discussed in reference 22.

Data Reduction Procedures

Instantaneous sediment concentration and transport rates were determined from sample analysis and flow records.

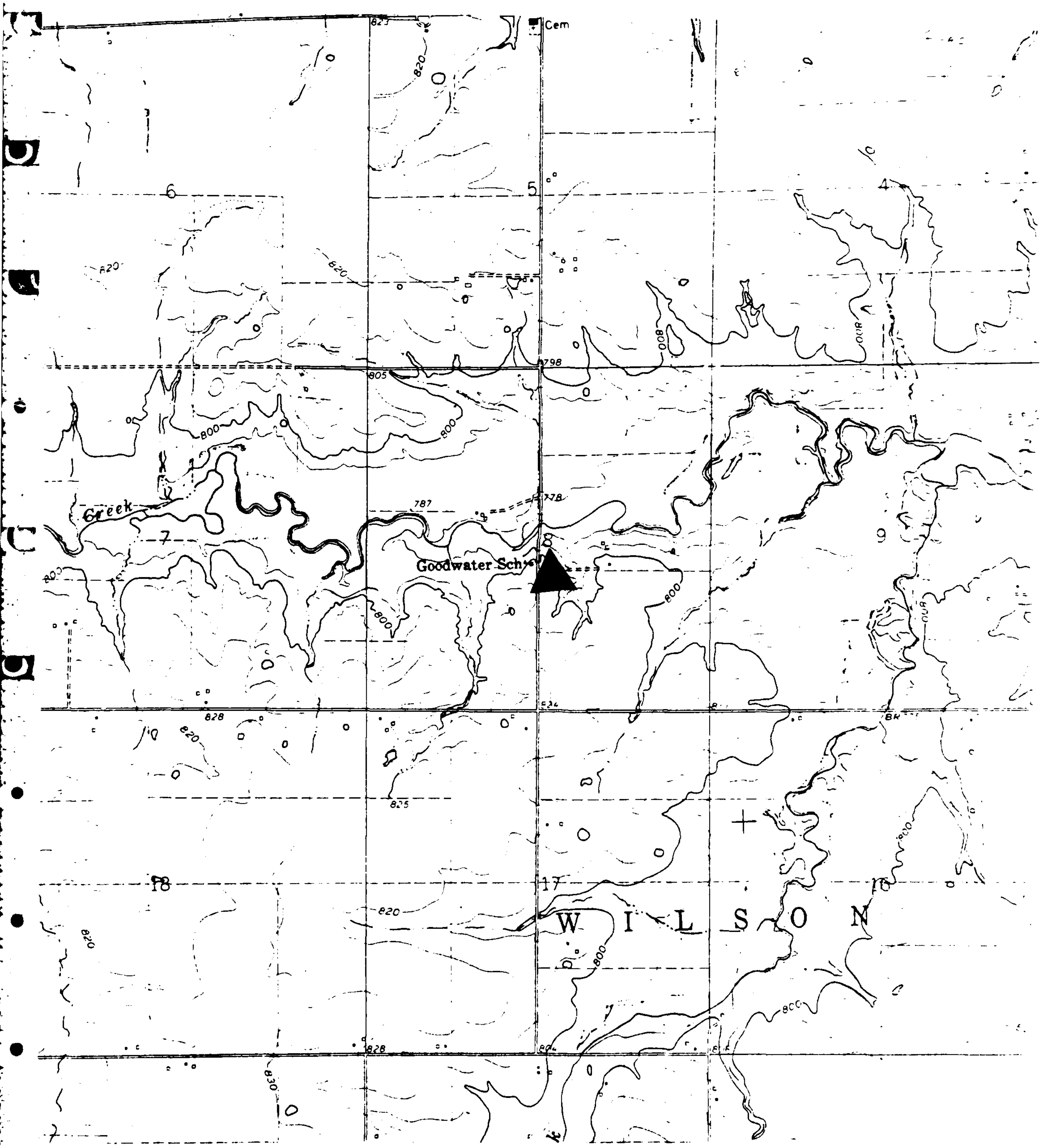
Data Reporting Procedures

Runoff and sediment data maintained in Agricultural Research Service, Watershed Research Unit office.

General Information

Information concerning this sediment collection station can be obtained from USDA, Agricultural Research Service, Watershed Research Unit, 207 Business Loop 70 E, Columbia, Missouri 65201. Similar data for two additional gaging stations within the Goodwater Creek basin representing 5 and 12.2 square mile watersheds are also available.

Figure 8 -- Sediment Sample Collection Location for Goodwater Creek near Centralia, Missouri



Youngs Creek near Mexico, Missouri

SOURCE: From U.S. Geological Survey Files

Station Identification

OWDC No.: 07365

Agency Station Number: 05506000

Latitude/Longitude: 391839/915651

Agency reporting to OWDC: U.S. Geological Survey

Drainage area: 67.4 square miles

River mile: 103.3 miles upstream from the confluence of the Salt River with the Mississippi River. The Salt River is at river mile 284.2 (mile 0 is at the confluence of the Mississippi and Ohio Rivers; established by the Corps of Engineers in 1930).

Site Description

The station is located at the State Highway 15 bridge, 11 miles north of Mexico, Missouri (Figure 9). The water-level instrumentation is on the downstream side of the bridge, and the sediment sampler is on the upstream side. The stream channel is straight several hundred feet upstream and downstream from the bridge. Trees are scattered along both banks. The right bank is subject to overflow at a gage height of 19 feet, and the left bank overflows at a gage height of 17 feet. The channel is composed of sands and silts and has a median streambed particle size of 1.0 millimeter in diameter. Discharges of record (April 1930 to September 1969) are: maximum - 8,120 cfs; minimum - no flow.

Station Chronological Record

This station was established during April 1930 to provide daily discharge values. During October 1969, daily discharge data collection was discontinued, but crest-stage data were still collected. During July 1980, the station was reestablished as a daily discharge record station and daily sediment station. At this time a suspended sediment sampler was attached to the upstream side of the bridge and daily sediment samples were obtained by an observer.

Sample and Data Collection Procedures

Sampling for suspended sediment began November 28, 1980, by U.S. Geological Survey personnel, in accordance with procedures discussed in reference 6. Daily depth-integrated samples are collected from a stationary sampling station using a US D-74. Once a month the complete cross section is sampled by the equal-transit-rate (ETR) method (equal spacing between verticals) discussed in reference 6 using a US P-61, US D-74, or a US DH-48. The monthly samples are

used, along with the daily single vertical samples and daily river stage, to obtain an average daily suspended sediment concentration (reference 16). An explanation of the samplers used may be found in reference 21.

Laboratory Sample Analysis

Suspended sediment concentration analyses are performed by the U.S. Geological Survey laboratory at Rolla, Missouri, according to procedures discussed in reference 22.

Data Reduction Procedures

The sediment records will be computed using standard U.S. Geological Survey methods as discussed in reference 16. The complete river stage hydrograph is plotted, the suspended sediment data are evaluated and plotted with the stage hydrograph, the suspended sediment curve is drawn from the plotted points using the stage hydrograph as a guide, then the daily suspended sediment values are taken from this graph and stored in the computer. The daily sediment discharge is calculated from the daily suspended sediment and daily discharge values.

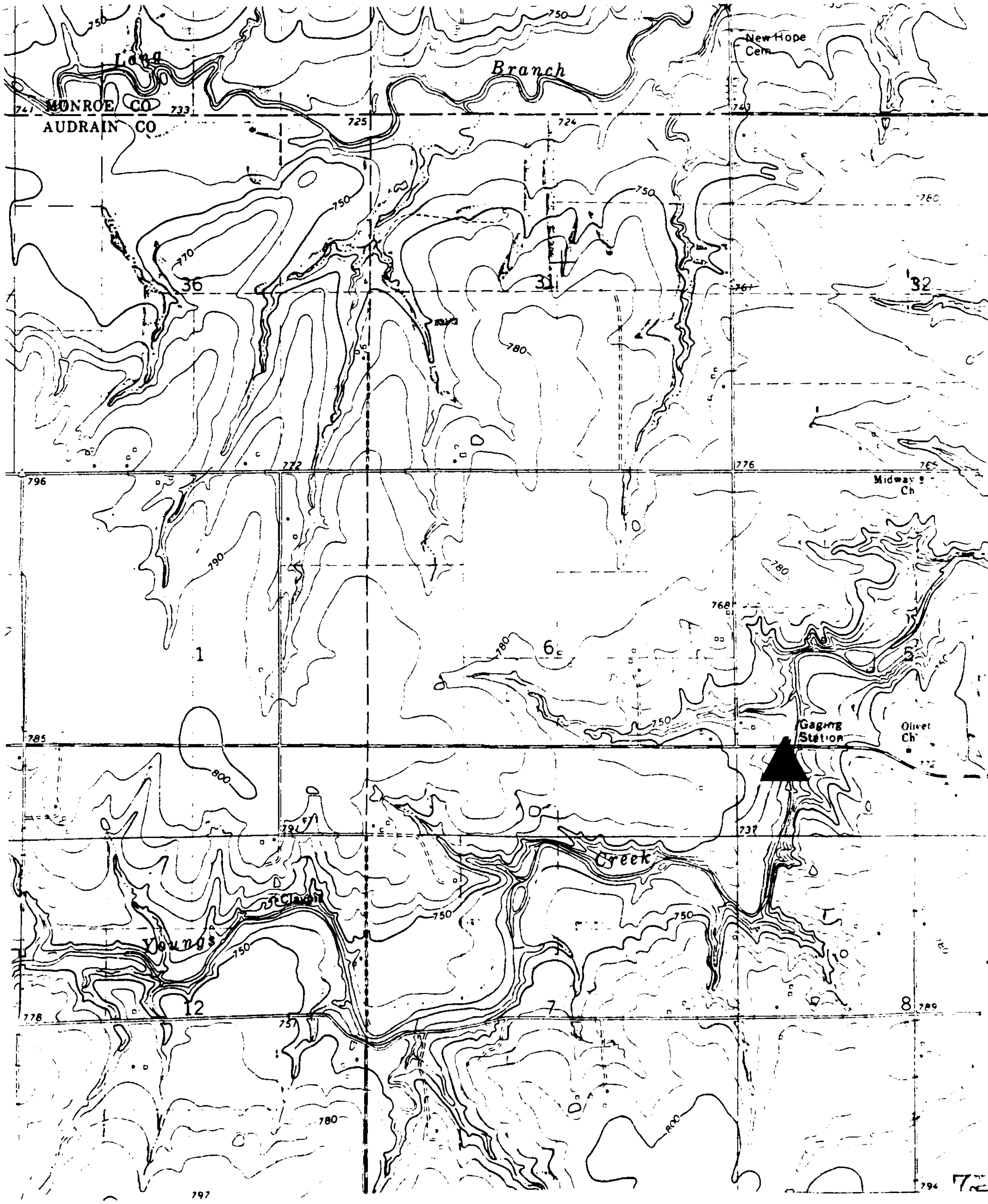
Data Reporting Procedures

Daily and monthly sediment discharge and daily suspended sediment concentrations will be published in "Water Resources Data for Missouri" for each water year.

General Information

Information concerning this sediment sample-collection station can be obtained from: District Chief, U.S. Geological Survey, Water Resources Division, Mail Stop 200, 1400 Independence Road, Rolla, Missouri 65401.

Figure 9 -- Sediment Sample Collection Location for Youngs Creek near Mexico, Missouri



South Fork Salt River near Santa Fe, Missouri

SOURCE: U.S. Geological Survey Files

Station Identification

OWDC No.: None assigned

Agency Station No.: 05505000

Latitude/Longitude: 392145/914905

Agency Reporting to OWDC: U.S. Geological Survey

Drainage area: 298 square miles

River mile: 96.2 miles upstream from the confluence of the Salt and Mississippi Rivers. The Salt River is at river mile 284.2 (mile 0 is at the confluence of the Mississippi and Ohio kivers; established by the Corps of Engineers in 1930).

Site Description

The station is located at a county highway bridge crossing the South Fork Salt River 0.3 mile south of Santa Fe, Missouri (Figure 10). The discharge instrumentation is housed in a metal shelter at the left upstream end of the bridge. The left bank is high and not subject to overflow. The right bank is cultivated and subject to overflow at gage heights above 14.0 feet. The streambed is composed of sand and gravel with a median particle size of approximately 0.5 millimeter in diameter. Records of discharge (February 1940 to September 1979) are: Maximum - 28,000 cubic feet per second (October 13, 1969); Minimum - No flow.

Station Chronological Record

This station was established in February 1940 to provide daily discharge values. During May 1980, sampling for daily suspended-sediment data began.

Sample and Data Collection Procedures

Sampling for suspended sediment began July 9, 1980, by U.S. Geological Survey personnel, according to the procedures discussed in reference 6. Daily depth-integrated samples are collected by an observer. During low-flow conditions, the observer takes a wading sample using a US DH-48, and during high-flow conditions the observer takes a sample from the bridge using a US D-74. Once a month USGS personnel sample the complete river cross section by the equal-transit-rate (ETR) method (equal spacing between verticals) as discussed in reference 6, using s US P-61 or a US DH-48. The monthly and daily sediment samples and river stage values are used to obtain mean daily suspended-sediment concentrations (reference 16). An explanation of the samplers used may be found in reference 21.

Laboratory Sample Analysis

Suspended-sediment concentration analyses are made by the U.S. Geological Survey laboratory at Rolla, Missouri, according to procedures discussed in reference 22.

Data Reduction Procedures

The sediment records will be computed using standard U.S. Geological Survey methods, as discussed in reference 16. The complete river-stage hydrograph is plotted, the suspended-sediment data are evaluated and plotted with the stage hydrograph, the suspended-sediment curve is drawn from the plotted points using the stage hydrograph as a guide, then the daily suspended-sediment values are taken from this graph and stored in the computer. The daily sediment discharge is calculated from the daily suspended-sediment and daily discharge values.

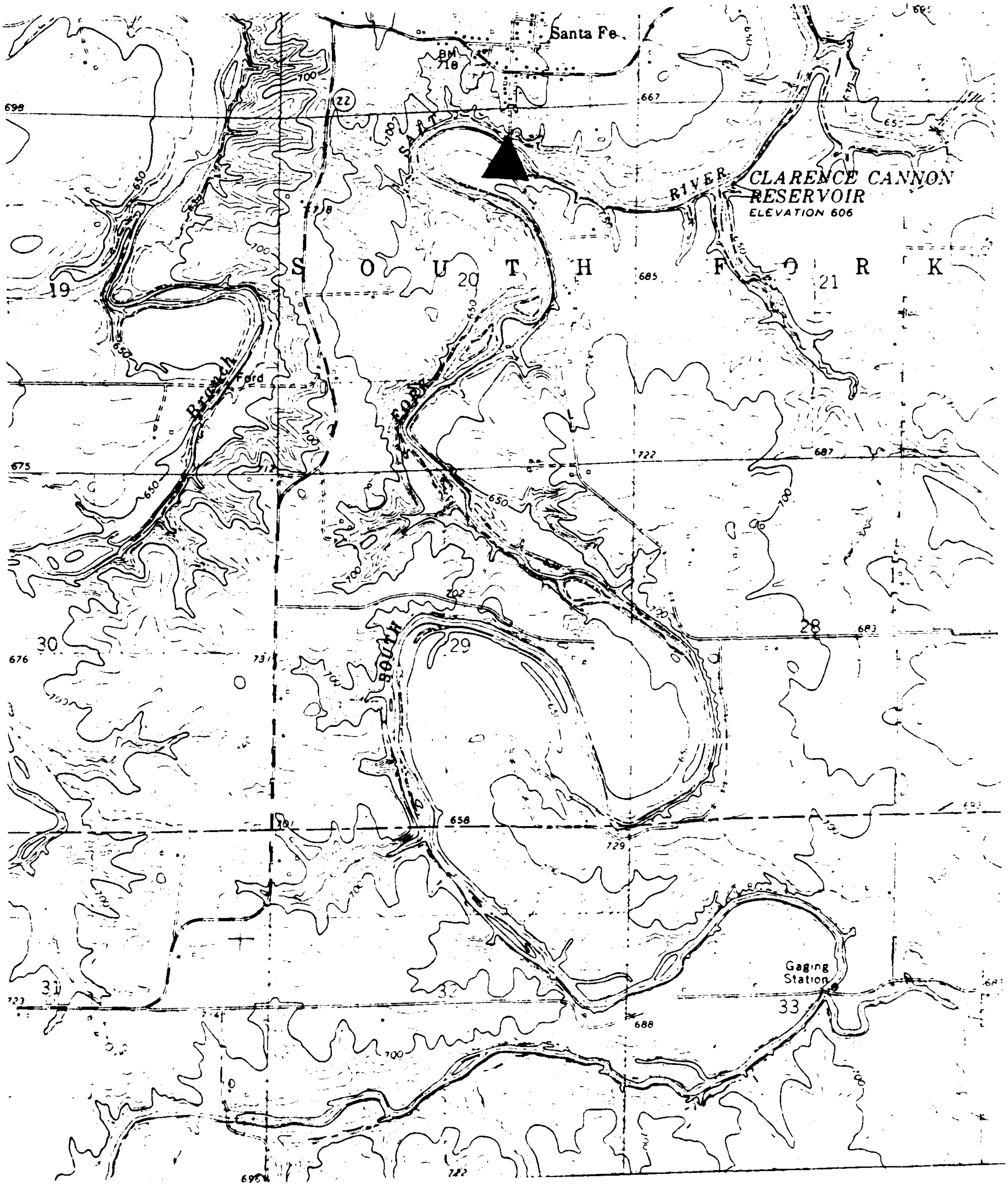
Data Reporting Procedures

Daily and monthly sediment discharge and daily suspended-sediment concentrations will be published in "Water-Resources Data for Missouri for each water year.

General Information

Information concerning this sediment sample-collection station can be obtained from: District Chief, U.S. Geological Survey, Water Resources Division, Mail Stop 200, 1400 Independence Road, Rolla, MO 65401.

Figure 10 -- Sediment Sample Collection Location for South Fork Salt River near Santa Fe, Missouri



Salt River near Monroe City, Missouri

SOURCE: U.S. Geological Survey Files

Station Identification

OWDC No.: 07367

Agency Station No.: 05507500

Latitude/Longitude: 393225/914020

Agency reporting to OWDC: U.S. Geological Survey

Drainage area: 2,230 square miles

River mile: 63.5 (the Salt River enters the Mississippi River at river mile 284.2 where mile 0 is at the confluence of the Mississippi and Ohio Rivers; established by the the Corps of Engineers in 1930).

Site Description

This station is located on the County Road J bridge (mile 63.5) at Joanna, 2,500 feet downstream from Indian Creek, 2 miles upstream from Lick Creek (Figure 11). The discharge gaging station is located on the left bank on the downstream side of the old bridge pier, 135 feet upstream from County Road J Bridge. The left bank is a high rock bluff while the right bank overflows at a river stage of 26 feet. The streambed is composed of sand and gravel. The discharges of record (October 1939 to October 1978) are: maximum - 102,000 cfs (1973); mean - 1,526 cfs; minimum - no flow (1954).

Station Chronological Record

This station was established on October 1, 1939, by the U.S. Geological Survey as a water-discharge record station. Periodic suspended sediment samples were collected between October 1941 and October 1966. Daily suspended sediment samples were collected between July 15, 1980, and September 30, 1981. These samples, however, are useless due to backwater effects caused by construction of the Clarence Cannon Dam.

Sample and Data Collection Procedures

Sampling for suspended sediment was done by observers from October 1941 to October 1966. The frequency of sampling was dependent upon gage height. One sample per week was obtained when the gage height was below 5 feet, one sample per day was obtained when the gage height was between 5 and 20 feet, two samples per day were obtained when the gage height was between 20 and 26 feet, and three samples per day were obtained when the gage height was greater than 26 feet. Observers took samples from a fixed location in the river. Samples were collected in pint milk bottles held in a small brass holder and lowered into the

river on a handline. Each bottle is fitted with a stopper having a small intake opening and air vents. Sample bottles are raised and lowered at a constant rate.

Samples are taken by USGS personnel, approximately once a month, at four locations in the river selected to represent four volumes of equal discharge. Simultaneously, a sample is taken at the observer's location to determine coefficient relationships between samples taken by the observer and USGS personnel.

There are large time gaps in this data and values have not been published.

Laboratory Sample Analysis

Suspended sediment concentration and particle size analysis was done by the USGS laboratory at St. Louis, Missouri. The grain size classes determined by partizle size analysis are percentage less than 0.005 m.m., 0.025 m.m., 0.030 m.m., and 0.074 m.m.

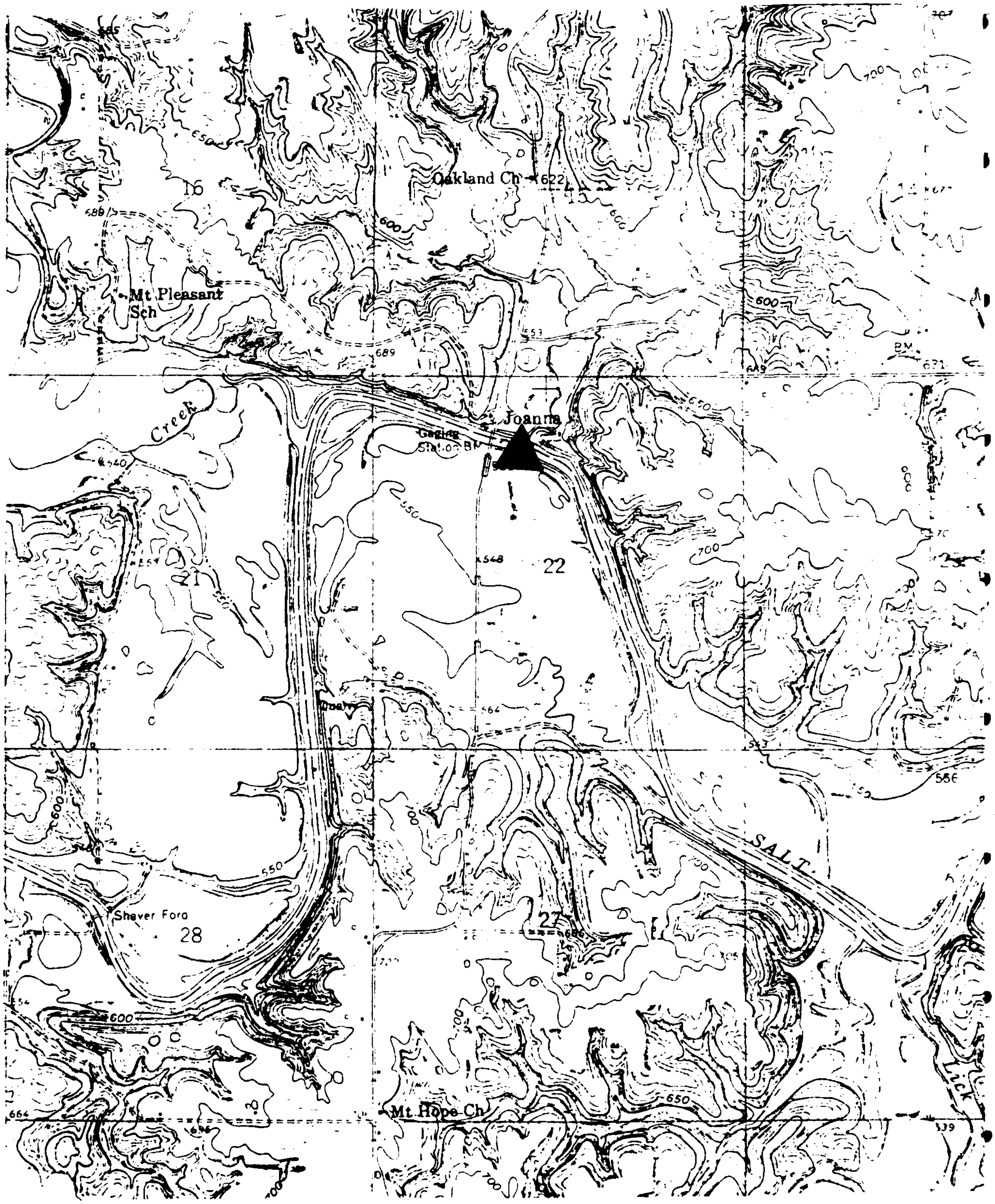
Data Reporting Procedures

The suspended sediment concentration values and results from particle size analyses have never been published.

General Information

Information concerning this sediment sample collection station can be obtained from: District Chief, U.S. Geological Survey, Water Resources Division, Mail Stop 200, 1400 Independence Road, Rolla, Missouri 65401.

Figure 11 -- Sediment Sample Collection Location for Salt River near Monroe City, Missouri



Salt River near New London, Missouri

SOURCE: U.S. Geological Survey Files

Station Identification

OWDC No.: 07368

Agency Station No.: 05508000

Latitude/Longitude: 393644/912430

Agency reporting to OWDC: U.S. Geological Survey

Drainage area: 2,480 square miles

River mile: 35.5 (the Salt River enters the Mississippi River at river mile 284.2 where mile 0 is at the confluence of the Mississippi and Ohio Rivers; established by the Corps of Engineers in 1930).

Site Description

The station is located at U.S. Highway 61 at river mile 35.5, 8 miles upstream from Spencer Creek (Figure 12). The gaging station is located on the left bank 180 feet upstream from the upstream bridge. The right bank is subject to overflow at a river stage of 19 feet and the left bank at 23 feet. The streambed is composed of silt and sand. The discharges of record (February 1922 to September 1981) are: maximum - 107,000 cfs (1973); mean - 1,660 cfs; minimum - no flow (1936). The suspended sediment loads of record (July 1980 to September 1981) are: maximum - 143,000 tons/day (1981); minimum - 0.45 tons/day (1980).

Station Chronological Record

On February 16, 1922, this station was established by the U.S. Geological Survey as a daily discharge record station. On March 14, 1979, monthly suspended sediment and sand break samples were obtained in conjunction with the National Stream-Quality Accounting Network (NASQAN) program. On July 8, 1980, daily suspended sediment sampling began with periodic particle size samples of suspended material, bedload, and bad material. All data collection at this station has been the responsibility of the USGS Missouri District.

Sample and Data Collection Procedures

Samples collected under the NASQAN program are collected monthly. A determination is made of the suspended sediment concentration in the sample and the percentage of the material with a diameter less than 0.062 millimeters (sand break). Sampling for daily suspended sediment and particle size of suspended material, bedload, and bed material began July 8, 1980, by USGS personnel according to procedures discussed in reference 6.

Daily depth-integrated samples are collected from a stationary sampling station from the bridge using a US D-74. Once a month the complete cross section is sampled by the equal-transit-rate (ETR) method (equal spacing between verticals) or the equal-discharge-interval (EDI) method discussed in reference 6 using a US P-61, US D-74, or a US DH-48. The monthly samples are used along with the daily single vertical samples and daily river stage to obtain an average daily suspended sediment concentration (reference 16). Five bed material samples were obtained using a US BM-54 sampler. Three samples for suspended sediment particle size were collected during highflows. Two bedload samples were collected using a Helly-Smith bedload sampler. An explanation of the samplers used may be found in reference 21.

Laboratory Sample Analysis

Sand break and suspended sediment concentration analysis is preferred by the USGS laboratory at Rolla, Missouri. Particle size analysis of suspended material, bedload, and bed material are performed by the USGS sediment laboratory at Iowa City, Iowa, following procedures discussed in reference 22. A dispersing agent is added to the suspended material during analysis while distilled water is used when analyzing bedload and bed material. The size classes analyzed for are 0.002, 0.004, 0.008, 0.016, 0.062, 0.125, 0.25, 0.50, 1.0, 2.0, 4.0, 8.0, 16.0, 32.0, and 64.0 millimeters in diameter.

Data Reduction Procedures

The sediment records will be computed using standard USGS methods as discussed in reference 16. The complete river stage hydrograph is plotted, the suspended sediment data is evaluated and plotted with the stage hydrograph, the suspended sediment curve is drawn from plotted points using the stage hydrograph as a guide, then the daily suspended sediment values are taken from this graph and stored in the computer. The daily sediment discharge is calculated from the daily suspended sediment and daily discharge values.

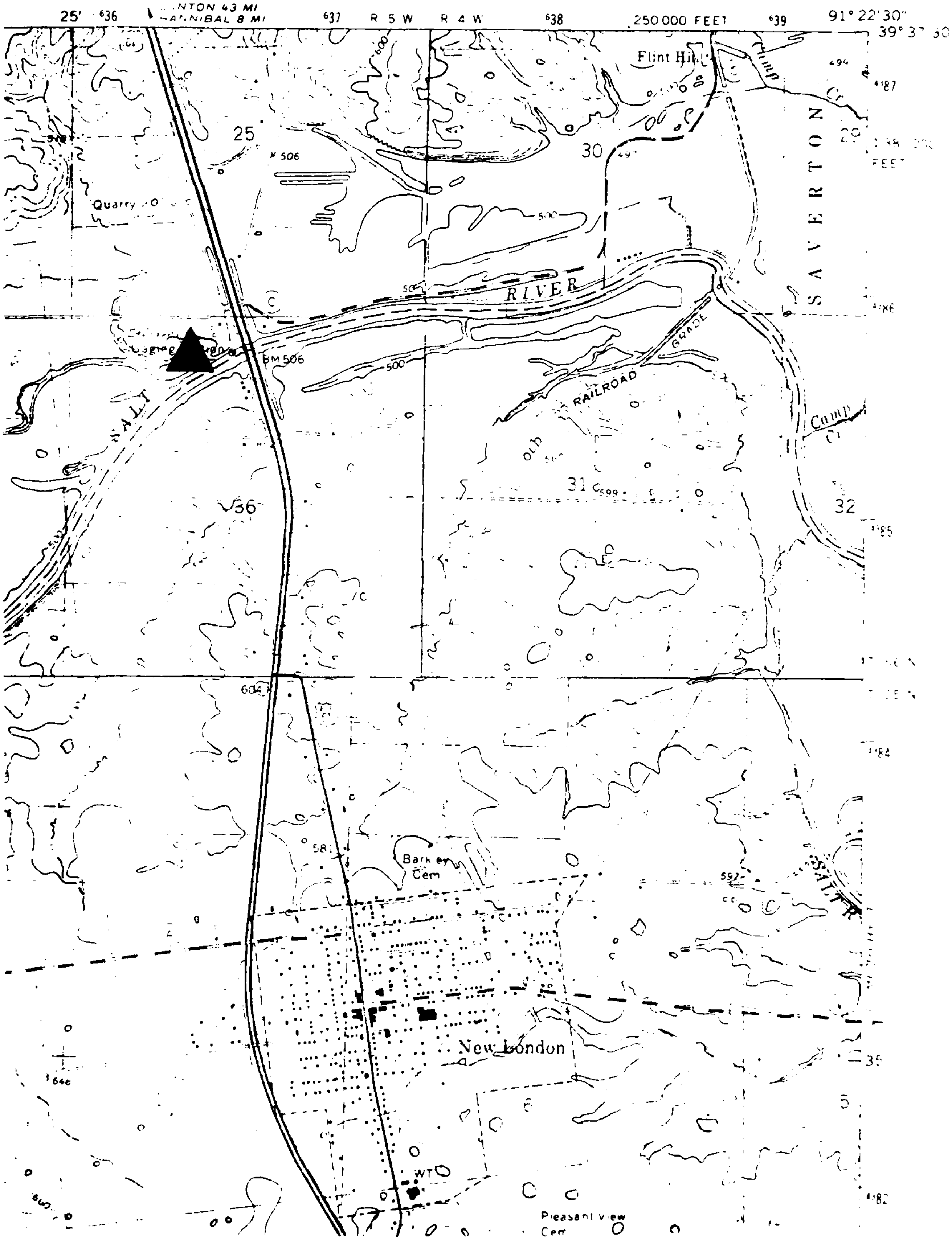
Data Reporting Procedures

Daily and monthly sediment discharge and daily suspended sediment concentrations along with periodic particle size and analyses of the suspended sediment and bottom material will be published in "Water Resources Data for Missouri" for each water year. This station is downstream from the Clarence Cannon Dam. Although the dam was not completed during the period of sediment record (July 1980 to September 1981), coffer dams were regulating the flow at the dam location. Because of this, the data collected cannot be used to make estimates of sediment load over the period of discharge record.

General Information

Information concerning this sediment sample-collection station can be obtained from: District Chief, U.S. Geological Survey, Water Resources Division, Mail Stop 200, 1400 Independence Road, Rolla, Missouri 65401.

Figure 12 -- Sediment Sample Collection Location for Salt River near New London, Missouri



Bay Creek at Nebo, Illinois

SOURCE: Taken from USGS and Rock Island District
U.S. Army Corps of Engineers Records

Station Identification

OWDC No.: 08876

Agency Station No.: 05513000

Latitude/Longitude: 392635/904745

Agency reporting to OWDC: USGS/USCE

Drainage area: 161 square miles

River mile: 6.8 (Bay Creek joins the Mississippi River through Sixmile Diversion Ditch whose mouth is at Mississippi River mile 273.0 (mile 0 is at the confluence of the Mississippi and Ohio Rivers; established by the Corps of Engineers in 1930)).

Site Description

Miscellaneous suspended sediment sample collection was started by the U.S. Army Corps of Engineers, Rock Island District (RID) in 1947 from the highway bridge about 640 feet upstream of Spring Creek, 0.2 mile west of Nebo, and 1.6 mile upstream of the Chicago and Alton Railroad bridge (Figure 13). The streambed is mainly composed of silt and clay, however, at spots coarse gravel may be observed. The channel gradient is 5.6 feet per mile. Daily discharges of record (1939-1981) are: maximum - 13,600 cfs; mean - 96 cfs; and minimum - no flow. The maximum daily suspended sediment discharge on record is 649,000 tons per day on August 16, 1946. The calculated annual suspended sediment loads of record (1939-1980) are: maximum - 862,000 tons (1946), mean - 292,400 tons, and minimum -3,200 tons (1940).

Station Chronological Record

The RID began collecting suspended sediment samples periodically in an effort to develop a sediment rating curve in April 1947. In 1965 a sediment observer was hired and a sediment collection station installed on the bridge. The Illinois district of the USGS Water Resources Division has maintained a recording stream gage at this location since October 1939. As part of a special 1-year project, USGS personnel sampled periodically during water year 1980.

Sample and Data Collection Procedures

Depth-integrated, suspended sediment samples have been collected about three times a week by a RID paid observer using a US D-43 sampler. Particle size analyses have been performed on the average of four times a year. Since April 1979 multi-vertical cross sections have been collected on at least a once a month basis by USGS personnel. As part of the 1-year project, USGS personnel

are attempting to define the relationship between samples collected at the observer station vertical and the mean concentration at the bridge cross section (see reference 6). USGS personnel use US DH-59 or US D-74 suspended sediment samplers and US BMH60's when bed material sampling (see reference 23 for an explanation of these samplers).

Laboratory Sample Analysis

All sediment sample analysis since at least 1970 has been performed by the USGS sedimentation laboratory at Iowa City, Iowa, following procedures discussed in reference 22.

Data Reduction Procedures

Prior to 1968 all computations of suspended sediment load were performed manually, and no attempt was made to interpolate missing sediment concentration values. Since 1968, the suspended sediment concentration data and daily average flow rates have been punched into computer cards and input to a computer program (documented in reference 11), which computes daily suspended sediment loads. This program is capable of handling interpolation of up to 29 consecutive days of missing suspended sediment concentration records, provided discharges were obtained on those days. The program, however, will not attempt to interpolate suspended sediment concentrations for more than 29 consecutive days of missing records.

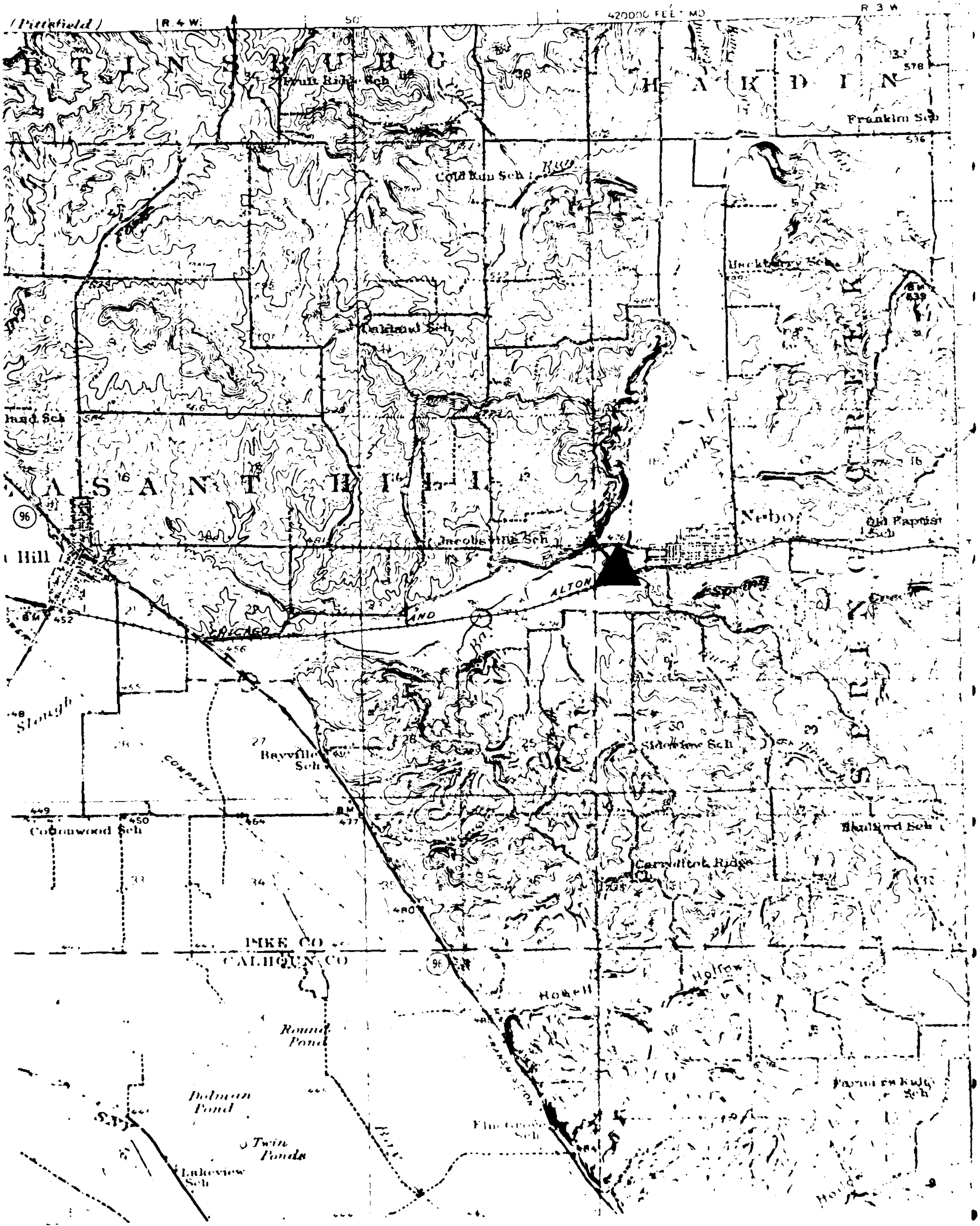
Data Reporting Procedures

Suspended sediment load values are not published. The RID, however, is attempting to obtain computer printouts (for in-house use at present) of its data at least as far back as 1968. The 1-year special study is to be published as an open-file report by the Illinois District of the USGS Water Resources Division (see reference 24). Mean daily flow records, bi-hourly flow records, and suspended sediment concentration measurements are in computer storage at the University of Missouri at Rolla for water years 1968-69, 1975-76, October-November 1970, and August-September 1974. No grain size analyses have been done.

General Information

Information concerning this sediment sample collection station can be obtained from: District Engineer, U.S. Army Engineer District, Rock Island, Hydraulics Section, Clock Tower Building, Rock Island, Illinois 61202. Information on the 1-year study ban be obtained from: District Chief, U.S. Geological Survey, Water Resources Division, Champaign County Bank Plaza, 4th Floor, 102 E. Main St., Urbana, Illinois 61801

Figure 13 -- Sediment Sample Collection Location for Bay Creek at Nebo, Illinois



Illinois River at Valley City, Illinois

SOURCE: U.S. Geological Survey Files

Station Identification

OWDC No.: 84507

Agency Station No.: 05586100

Latitude/Longitude: 394210/903840

Agency reporting to OWDC: U.S. Geological Survey

Drainage area: 26,564 square miles

River mile: 61.3 from the confluence of the Illinois and Mississippi Rivers. The confluence is at Mississippi River mile 217.5 (mile 0 is at the confluence of the Mississippi and Ohio Rivers; established by the Corps of Engineers in 1930).

Site Description

Beginning in December 1974 water samples have been collected from the Norfolk and Western Railway lift-bridge which is located across Alton pool, 8.9 river miles downstream from LaGrange Lock and Dam (Figure 14). Alton pool elevation is maintained at 419 feet above mean sea level by lock and dam number 26 at Alton, Illinois, across the Mississippi River. Streamflows within Alton pool are greatly influenced by backwater created by Lock and Dam 26. Discharges within this reach are determined by development of a slope-stage-discharge relation with the Valley City site as the auxiliary gage and a station at Meredosia (10.0 river miles upstream) as the base gage (discharge record since October 1938). Discharge is routinely measured at the Meredosia bridge. At both sites discharge is assumed to be the same for a defined range in slope; beyond this range a correction factor has to be employed. Streambed elevation drops from about 410 feet above mean sea level immediately downstream of the LaGrange Dam, to 393 feet above mean sea level at the mouth of the Illinois River (a bed slope of 0.21 feet per mile). The daily discharges of record are: maximum - 123,000 cfs; minimum - 1,740 cfs. The maximum, minimum, and mean daily sediment loads for the period 2/80 to 9/80 are maximum - 410,000 tons/day, minimum - 1,220 tons/day, and mean - 28,103 tons/day. Not enough data are presently available to estimate sediment loads.

Station Chronological Record

This site was established by the Illinois District of the Water Resources Division of the USGS as a NASQAN (national stream quality accounting network) station in water year 1975. Since that time, suspended sediment samples have been collected routinely on a monthly basis. In February 1980, daily sampling was started with increased sampling frequency following rises in the stream.

Sample and Data Collection Procedures

Depth-integrated water samples for suspended sediment, as well as other NASQAN parameters have been collected by USGS personnel using sediment samplers such as the US DH-76 and US DH-59. In February 1980, the observer was supplied with a US DH-59. A stationary sampling station was installed on the bridge in October 1980, equipped with a US P72 (aluminum US P61). A brief but pertinent explanation of these samplers may be found in reference 23. Depending on flow conditions, the USGS pesonnel may use any one of these samplers. The observer always takes samples from a fixed location. In order to determine the mean stream sediment concentrations and the relationship between the samples collected from the observer location and the mean concentration, multi-vertical depth integrated samples are collected on a six-week basis. These samples are analyzed for concentration and for particle size distribution. Following selected large storms, special data collection trips are undertaken to collect suspended sediment, bedload (mainly coarse material skipping and rolling along the streambed), and bed material. Bedload is collected using the Helley-Smith bedload sampler and bed material is gathered using a US BM54 or a US BMH60.

Laboratory Sample Analysis

All sediment sample analysis has been performed by the USGS sedimentation laboratory at Iowa City, Iowa, following procedures discussed in reference 22.

Data Reduction Procedures

All sediment records since February 1980 will be computed using standard USGS methods as discussed in reference 16 and 25. The complete river stage hydrograph is plotted, all lab data is evaluated for consistency and validity, all valid lab data is plotted along the stage hydrograph, storm periods are drawn and computed, all the daily mean concentrations are entered into the computer, the computer calculates the nonstorm daily loads, the storm period concentrations and loads are entered and a printout of mean daily discharge, the corresponding mean daily concentration and the corresponding daily load for the February to the end of September period is retrieved, checked and published.

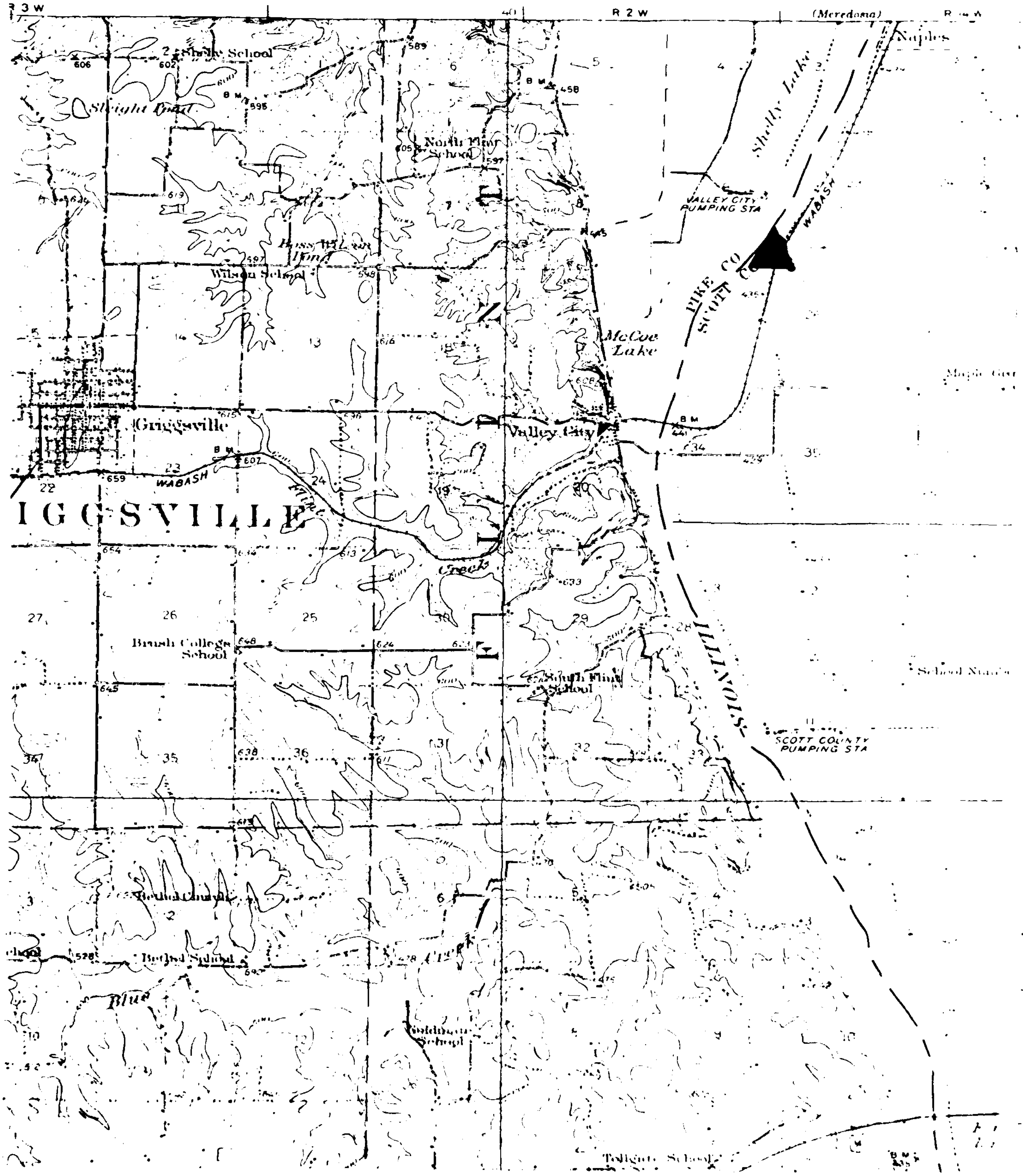
Data Reporting Procedures

Daily and monthly sediment discharge, and daily concentrations will be published in "Water Resources Data for Illinois" for water year 1980.

General Information

Information concerning this sediment sample collection station can be obtained from: District Chief, U.S. Geological Survey, Water Resources Division, Champaign County Bank Plaza, 4th Floor, 102 E. Main St., Urbana, Illinois 61801.

Figure 14 -- Sediment Sample Collection Location for Illinois River at Valley City, Illinois



<u>Mississippi River at Alton, Illinois</u>

SOURCE: U.S. Geological Survey Files

Station Identification

OWDC No.: 07372

Agency Station No.: 05587500

Latitude/Longitude: 385306/901051

Agency reporting to OWDC: U.S. Geological Survey

Drainage area: 171,500 square miles

River mile: 202.7 (Mile 0 is at the confluence of the Mississippi River and Ohio Rivers; established by the Corps of Engineers in 1930).

Site Description

This station is located on the Burlington Northern railroad bridge, which crosses the Mississippi River at mile 202.8 (Figure 15). The stream gaging station is located near the left bank and downstream end of intermediate lock wall of Lock and Dam 26, 300 feet downstream from Burlington Northern railroad bridge. The confluence of the Missouri River is 7.7 miles downstream from the gage. The gage is affected by backwater from the Missouri River and by rock dam at mile 190.3. An auxiliary gage at Hartford, Illinois (mile 196.8), is used to determine fall for discharge computation as a slope gage. When the stage at St. Charles on the Missouri River exceeds 34 feet, floodwater enters the Mississippi River above the station at Alton. Discharge measurements of the overflow must be made to determine the volume of Missouri River water entering above the gage. Discharge and sediment measurements are made off of the Burlington Northern railroad bridge. The streambed consists of silts and sands, and the channel gradient is approximately 0.5 foot per mile. The daily discharges of record (1927 to 1981) are: maximum - 535,000 cfs (1973); mean - 99,000 cfs; minimum - 7,960 cfs (1948). The suspended sediment loads of record (October 1980 to September 1981) are: maximum - 1,120,000 tons/day (1981); minimum - 1,290 tons/day (1981).

Station Chronological Record

Monthly suspended sediment samples have been collected downstream from this station since October 1974 for the NASQAN program. Daily suspended sediment and particle size of suspended material and bed material have been collected since May 20, 1980 for the GREAT III program. Sample collection, sample laboratory analysis, data reduction and data publications are the responsibility of the USGS Missouri District.

Sample and Data Collection Procedures

Samples collected under the NASQAN program are collected monthly. A determination is made of the suspended sediment concentration in the sample and

the percentage of the material with a diameter less than 0.062 millimeters (sand break).

Sampling for suspended sediment, particle size and bed material began May 1980, by USGS personnel according to procedures discussed in reference 6. Twice weekly depth-integrated samples are collected from a stationary sampling station using a US P-61. Once a month the complete cross section is sampled by the equal-transit-rate (ETR) method (equal spacing between verticals) discussed in reference 6 using a US P-61. The monthly samples are used along with the twice weekly single vertical samples and daily river stage to obtain an average daily suspended sediment concentration (reference 16). Nine bed material samples have been obtained using a US BM-54 sampler. Five samples for suspended sediment particle size have been collected. An explanation of the samplers used may be found in reference 21.

Laboratory Sample Analysis

Sand break and suspended sediment concentration analyses are preferred by the USGS laboratory at Rolla, Missouri. Particle size analysis of suspended material, bedload, and bed material are performed by the USGS sediment laboratory at Iowa City, Iowa, following procedures discussed in reference 22. A dispersing agent is added to the suspended material during analysis while distilled water is used when analyzing bedload and bed material. The size classes analyzed for are 0.002, 0.004, 0.008, 0.016, 0.062, 0.125, 0.25, 0.50, 1.0, 2.0, 4.0, 8.0, 16.0, 32.0, 64.0, millimeters in diameter.

Data Reduction Procedures

The sediment records will be computed using standard USGS methods as discussed in reference 16. The complete river stage hydrograph is plotted, the suspended sediment data is evaluated and plotted with the stage hydrograph, the suspended sediment curve is drawn from plotted points using the stage hydrograph as a guide, then the daily suspended sediment values are taken from this graph and stored in the computer. The daily sediment discharge is calculated from the daily suspended sediment and daily discharge values.

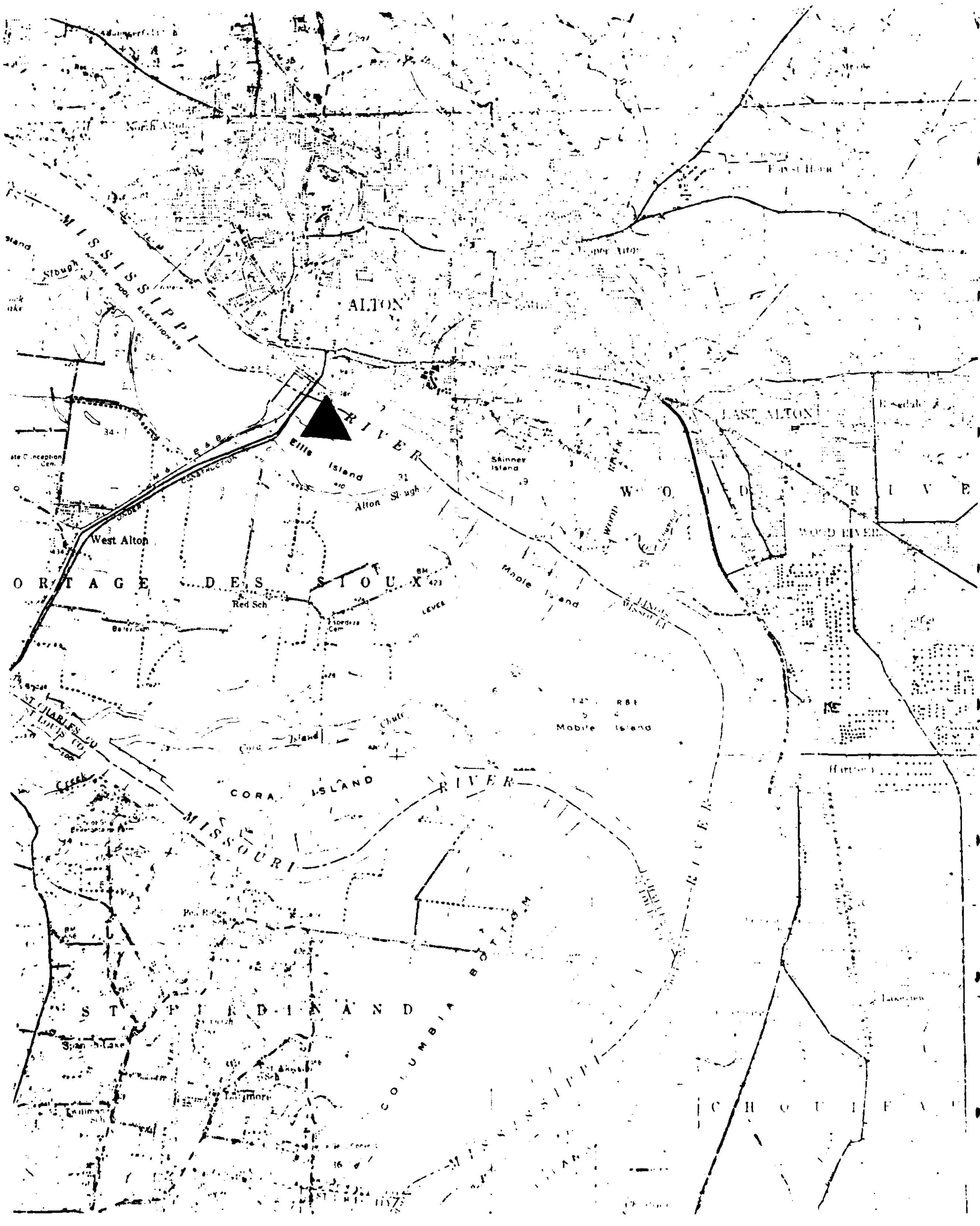
Data Reporting Procedures

Daily and monthly sediment discharge and twice weekly suspended sediment concentrations along with periodic particle size analyses of the suspended sediment and bottom material will be published in "Water Resources Data for Missouri" for each water year. This station is directly downstream from Lock and Dam 26. This station is affected by backwater from the Missouri River and Chain of Rocks Dam at river mile 190.3. Because of these factors, poor correlation was found between suspended-sediment load and discharge for the period of sediment record. Thus, estimates of suspended sediment load were not made.

General Information

Information concerning this sediment sample collection station can be obtained from: District Chief, U.S. Geological Survey, Water Resources Division, Mail Stop 200, 1400 Independence Road, Rolla, Missouri 65401.

Figure 15 -- Sediment Sample Collection Location for Mississippi River at Alton, Illinois



Missouri River at Hermann, Missouri

SOURCE: Modified from Reference 1

Station Identification

OWDC No.: CE, 54659; USGS, 66939

Agency Station No.: CE, 11; USGS, 06934500

Latitude/Longitude: 384236/912621

Agency reporting to OWDC: CE; USGS

Drainage area: 524,200 square miles

River mile: 97.9 (Mile 0 at the confluence of the Missouri and Mississippi Rivers; miles 0-498.4 established by the CE in 1960, and upstream from mile 498.4 established by the CE in 1972.)

Site Description

The sediment sample collection and gaging stations at Hermann, Missouri, are at mile 97.9 on the Missouri State Highway 19 Bridge (Figure 16). The left bank is a fertile flood plain that is cultivated extensively. Along the right bank is a 70-ft-high limestone bluff; the area above this bluff line is rocky and topographically unsuited for agricultural activities. Protecting both banks are series of spur dikes at various angles spaced approximately 500 feet apart. These dikes are built of limestone riprap and are 30 feet wide at the base. Between mile 100.0 and mile 101.0 along the left bank is riprap revetment. There is a significant amount of barge traffic in this reach of the river. The nearest downstream docks are at mile 97.8 and mile 96.9, and the nearest upstream docks are at the mouth of the Gasconade River (mile 104.7) and at Chamois, Missouri (mile 117.1). River industry is limited principally to loading facilities for sand, gravel, and fuels.

The streambed material consists of sand, and the approximate channel gradient in this reach of the Missouri River is 0.9 ft/mile. Flow has been partially controlled by Gavins Point Dam since July 1955. The natural streamflow and sediment loads are also affected by numerous Kansas River Basin diversions (for irrigation) and control structures, the majority of which became operational between 1962 and 1969. The tabulation below summarizes the daily discharges and daily suspended sediment loads for this station for three periods: (a) beginning of periods of record - 1955 (period prior to control by Gavins Point Dam); (b) 1956-1969 (transitional period of construction of Gavins Point Dam and the various Kansas River Basin control structures); and (c) 1965-1980 (period since the Kansas River Basin control structures became operational):

Period	Maximum	Mean	Minimum
	Discharge, cfs		
1897-1955	676,000	79,500	11,000
1956-1969	401,000	70,800	6,210
1965-1980	500,000	13,900	83,500
	Suspended-Sediment Load, tons/day		
1949-1955	8,340,000	663,200	10,120
1956-1969	4,547,000	270,100	503
1965-1980*	2,387,000	254,000	1,000

*Loading no longer computed, concentration only available after 9/31/74

Station Chronological Record

This station was established by the CE Kansas City District (KCD) on August 19, 1948, to monitor changes in sediment loads in the reach of the Missouri River prior to, during, and after construction of the various upstream dams. In October 1974 this station was made a part of the National Stream Quality Accounting Network (NASQAN). Sample collection was the responsibility of the KCD prior to May 1968, and since that date, the samples have been taken by personnel of the USGS Missouri District. Sample laboratory analysis was handled by the KCD Laboratory from the beginning of the period of record through May 1973; since May 1973 the CE Missouri River Division (MRD) Laboratory in Omaha has analyzed the sediment samples. Data reduction and data publication have been the responsibility of the KCD throughout the period of record.

Sample Data
Collection Procedures

Five depth-integrated vertical samples are taken at least once a week. The sampler is mounted on a mobile crane. The spacings between the verticals are computed from discharge measurements taken prior to sampling by the USGS. The verticals pass through centroids of areas that pass an equal discharge (the equal-discharge-rate method, see Reference 6). During periods of high flow, as many as two or three samples a week are taken. The KCD personnel collected the suspended-sediment samples from June 4, 1948, to 1953 with a US P-46 sampler and from 1953 to 1968 with a US D-49 sampler. During the winter periods prior to 1968, where ice interfered with the sample collection, some surface grab samples were taken in place of the depth-integrated verticals. In 1968, the USGS Missouri District personnel assumed responsibility for sampling. Since 1968, the US P-61 sampler has been used to collect one-way (descending trip only) depth-integrated vertical samples. In 1972, the US P-61A1 sampler was put in service, it uses quart-size plastic bottles. In addition, since October 1972, the USGS has been using the US P-61A1 sampler to collect monthly point-integrated verticals with five to seven points per vertical for particle-size analysis; bed-material samples are taken at each vertical with a US BM-54 sampler. These samplers are discussed in Reference 6. Since 1963, temperatures

of samples have been measured. Collection of monthly samples for analysis of chemical and biological constituents began in October 1969; pesticide sampling began in October 1970.

The gaging station at Hermann was established on April 24, 1873 at mile 97.9. The following tabulation lists the gaging and recording devices in use at Hermann during the periods of record and the agencies responsible for collecting the data:

Period	Device Used
	CE
24 April 1873 - 31 December 1899	Inclined staff gage
	U.S. Weather Bureau (now National Weather Service)
1 January 1900 - 25 September 1930	Inclined staff gage (CE property)
26 September 1930 - 1981	Canfield wire-weight gage
30 January 1968 - 1981	Stevens Type T-4 Telemark gage (driven by manometer)
	USGS
17 August 1928 - 25 September 1930	Inclined staff gage (CE property)
26 September 1930 - 27 March 1932	Canfield wire-weight gage (Weather Bureau property)
28 March 1932 - 1981	Stevens A-35 recorder
21 December 1967 - 1981	Fisher-Porter automatic digital recorder (driven by manometer)

Laboratory Sample Analysis

Prior to May 1973, the samples were analyzed in the KCD Laboratory. No documentation is available on the procedures used in this laboratory. The resulting data included suspended sediment concentration and particle size distribution (on an irregular basis).

From May 1973 to present, the samples were analyzed in the CE Missouri River Division Soils Laboratory in Omaha following the procedures discussed in Reference 7-9. Particle size distributions were run on a regular basis.

Data Reduction Procedures

Prior to 1966, computations of daily suspended sediment loads were performed manually. From 1966-1969, a computer program requiring a large number of input parameters, including seasonal and terrain conditions as well as concentrations and discharges, was used. Although this program worked satisfactorily when used with the correct input, it proved to be too cumbersome. (No documentation is available on this program.) In 1969, the "Suspended Sediment Load Computer Program" (also referred to as the "Kansas City Load Program") was written. This program, a simplified version of the one in use from 1966-1969, requires inputs of only concentrations and two-hour discharges. These data are entered on computer cards via a remote terminal in Kansas City to the CDC-7600 computer in Berkeley, California. The program is capable of interpolating up to 59 days of missing concentration record, provided a two-hour discharge value is available; accuracy, of course, decreases as the width of the data gap increases. Reference 11 discusses the "Kansas City Load Program" and its use.

The USGS uses Water Resources Division programs to reduce its data; Reference 12 describes the procedures used.

Data Reporting Procedures

Suspended sediment data are published in Reference 13. Table 3 is an example of these data. Discharge data were published in Reference 14 from the beginning of the period of record through 1970 and in Reference 15 from 1961 to the present. Water quality data have been published in Reference 2 from 1970 to the present. Mean daily flows and suspended sediment concentration measurements for water years 1949 to 1980 are in computer storage at the University of Missouri at Rolla. The number of measurements since 1966 do not meet the minimum criteria of six readings per month. Suspended sediment grain size analysis are also available for water years 1949 to 1980.

General Information

The discharge record for Hermann is considered good; the sediment record for years prior to 1967 is considered fair, and after that date it is regarded as good. Further information on this station can be obtained from: U.S. Army Engineer District, Kansas City, Water Control Section, Hydrologic Engineering Branch, Engineering Division, 601 East 12th Street, Room 844, Kansas City, Missouri 64106; or U.S. Department of the Interior, Geological Survey, Water Resources Division, Mail Stop 200, 1400 Independence Road, Rolla, Missouri 65401.

Figure 16 -- Sediment Sample Collection Location for Missouri River at Hermann, Missouri

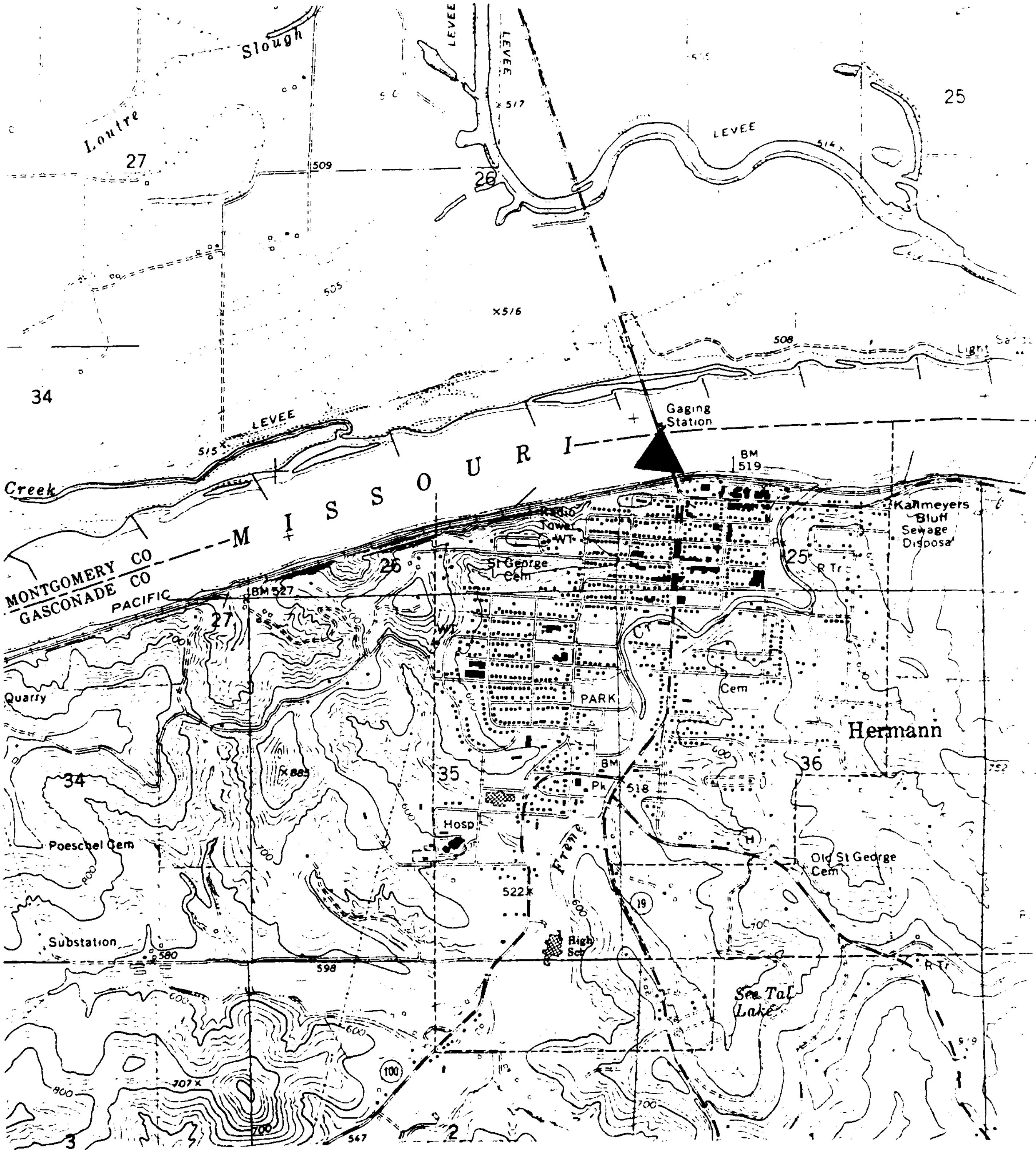


TABLE 3 -- Example of Sediment Data for Hermann, Missouri (Source: Suspended Sediment in the Missouri River, 1965-1969, U.S. Army Engineer District, Omaha, Nebraska)

MISSOURI RIVER AT HERMANN, MISSOURI

SUSPENDED SEDIMENT LOAD - TONS WATER YEAR OCT 1968 - SEP 1969

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	34,630	76,520	81,350	194,600	316,[illegible]	357,600	272,200	1,229,000	263,500	995,200	[illegible]	43,740
2	34,850	73,570	79,851	149,300	276,8[illegible]	[illegible]	235,200	854,000	401,800	1,374,000	[illegible]	42,050
3	34,850	66,940	81,770	106,500	[illegible]	176,500	157,900	[illegible]	[illegible]	[illegible]	[illegible]	42,590
4	36,380	66,620	81,220	81,850	[illegible]	207,900	161,300	[illegible]	380,[illegible]	[illegible]	[illegible]	47,250
5	33,900	68,040	74,390	59,590	123,1[illegible]	238,800	342,600	261,000	[illegible]	[illegible]	[illegible]	49,680
6	33,390	82,350	73,490	41,770	[illegible]	264,500	1,160,000	227,800	[illegible]	[illegible]	[illegible]	52,310
7	33,680	95,410	71,[illegible]	35,940	122,[illegible]	264,400	1,920,000	201,400	[illegible]	1,246,[illegible]	[illegible]	55,460
8	33,390	92,320	[illegible]	31,300	210,5[illegible]	257,600	1,603,000	160,600	[illegible]	[illegible]	[illegible]	62,370
9	[illegible]	[illegible]	66,440	[illegible]	[illegible]	224,500	1,600,000	[illegible]	141,4[illegible]	[illegible]	[illegible]	292,700
10	[illegible]	83,960	62,990	37,040	343,5[illegible]	189,100	1,363,000	[illegible]	[illegible]	[illegible]	[illegible]	326,500
11	[illegible]	78,210	62,230	41,600	273,900	155,900	1,202,000	544,200	126,600	1,444,[illegible]	[illegible]	234,000
12	[illegible]	76,140	53,450	37,610	219,2[illegible]	125,300	1,226,000	745,500	[illegible]	1,554,[illegible]	[illegible]	157,400
13	[illegible]	87,460	46,920	30,300	177,000	133,800	902,900	784,500	102,800	1,735,[illegible]	[illegible]	119,500
14	[illegible]	102,000	41,520	31,280	141,[illegible]	84,700	772,400	563,300	101,200	[illegible]	75,420	94,520
15	[illegible]	125,900	38,130	43,380	114,6[illegible]	72,730	711,300	351,500	243,200	1,163,000	73,390	83,540
16	[illegible]	221,800	33,060	61,550	85,820	61,740	633,700	239,800	388,500	810,800	72,770	148,500
17	[illegible]	280,100	28,590	92,730	67,460	51,700	734,100	176,200	355,900	573,800	73,240	633,900
18	[illegible]	253,400	31,350	135,300	51,230	50,970	1,179,000	147,300	284,200	411,300	135,300	560,200
19	[illegible]	213,800	29,970	147,900	56,370	60,940	1,660,000	121,700	314,000	306,200	[illegible]	493,900
20	511700	189,100	28,840	156,200	69,120	59,410	1,178,000	132,300	284,100	367,100	121,801	336,000
21	[illegible]	163,700	28,570	195,800	76,510	118,800	1,737,000	157,000	223,200	718,200	69,640	247,100
22	[illegible]	147,400	44,630	212,700	81,720	255,900	1,102,000	203,300	411,900	1,533,000	[illegible]	214,100
23	[illegible]	126,200	75,170	204,300	94,600	267,300	601,500	321,300	1,11[illegible]	868,300	[illegible]	197,200
24	[illegible]	106,400	62,930	221,300	98,850	264,700	613,900	699,200	1,736,000	670,200	[illegible]	197,000
25	[illegible]	94,590	49,970	156,100	101,300	484,100	497,700	863,200	1,810,000	573,200	59,310	269,700
26	143,400	82,900	36,080	99,550	104,900	570,700	416,100	753,00[illegible]	1,179,000	490,500	55,650	376,200
27	111,800	75,760	29,650	62,530	105,700	775,200	331,300	654,[illegible]	837,900	416,500	57,160	333,400
28	99,260	68,630	87,070	43,210	106,700	174,000	436,500	518,9[illegible]	[illegible]	356,500	[illegible]	219,600
29	74,360	60,940	113,500	64,100		662,600	904,400	[illegible]	[illegible]	[illegible]	[illegible]	172,800
30	63,180	55,080	219,400	255,700		463,200	1,103,000	[illegible]	357,500	251,000	[illegible]	139,700
31	55,350		273,800	499,500		371,500		197,1[illegible]		224,600	42,840	
	5871280	3,405,630	2,149,860	3,567,710	4,289,080	8,327,670	26,986,700	13,565,400	13,646,130	30,930,600	3,237,290	6,1[illegible]2,010

YEARLY TOTAL = 12[illegible] TONS

Mississippi River at St. Louis, Missouri

SOURCE: Modified from Reference 1

Station Identification

OWDC No.: 07444

Agency Station No.: 07010000

Latitude/Longitude: 383744/901047

Agency reporting to OWDC: USGS

Drainage area: 697,000 miles

River mile: 179.1 (Mile 0 is at the confluence of the Ohio and Mississippi Rivers; established by the CE in 1930.)

Site Description

From April 1948 to September 1968, suspended sediment samples were collected from the MacArthur Highway and railroad bridge (mile 178.9), which crosses the Mississippi River and links the cities of St. Louis, Missouri, and East St. Louis, Illinois (Figure 17). In September 1968, the station was moved to its present location, the Poplar Street Bridge (Interstate Highways 55 and 70) 0.2 miles upstream (Figure 5). The stream-gaging station is on the Eads Highway and railroad bridge (mile 180.0). Both the left (Illinois) bank and the right (Missouri) bank are protected by riprap upstream from the station, and an artificial levee parallels the left bank along this reach. Between the sediment station and the gaging station on the right bank are the Gateway Arch and Riverfront Park. Upstream from the gaging station are a number of highway railroad bridges and commercial docks. Lock and Dam No. 27 are located upstream at mile 185.6 and 190.3, respectively. The Missouri River enters the Mississippi River at mile 195.0. The urban and industrial areas of St. Louis and East St. Louis extend upstream from the sediment station for 6 miles and downstream for 4 miles along the left bank and 10 miles upstream and downstream along the right bank. The streambed material consists of silts, sands, and fine gravels, and the channel gradient is approximately 0.5 ft/mile. The discharges of record (1866 to September 1981) are: maximum daily -1,019,000 cfs (1903); mean daily - 176,600 cfs; and minimum daily - 18,000 cfs (1863). The natural flow of the Mississippi River is affected by many navigation dams in the upper Mississippi River Basin and by many dams and diversions for irrigation in the Missouri River Basin. The daily suspended sediment loads of record (April 1948 to September 1981) are: maximum - 7,010,000 tons/day; mean - 366,000 tons/day; and minimum - 2,800 tons/day. The estimated annual sediment loads of record (1949 to September 1981) are: maximum - 417,200,000 tons/year (1951); mean - 133,600,000 tons/year; minimum - 37,400,000 tons/year (1956).

Station Chronological Record

This station was established in April 1948 at a gaging station, with a long and reliable record, to monitor the sediment load contributed to the Mississippi River by the Missouri River. Sample collection, sample laboratory analysis, data reduction, and data publication are the responsibility of the USGS Missouri District.

Sample Data Collection Procedures

From April 1948 to September 1968, the USGS personnel collected sediment samples with a mobile crane at mile 178.9; since September 1968, the sediment samples have been collected at mile 179.1 from a trolley mounted on a monorail beneath the bridge. Throughout the period of record, sampling equipment, procedures, and frequency (once weekly except during extreme high flows, when samples are taken daily) have been the same. Since October 1954, two depth-integrated verticals (centroids of equal discharge) have been collected weekly. A US P-63 sampler is used during periods of high flow, and a US P-61 sampler is used the remainder of the time. Every four months suspended-sediment samples are taken along 10 verticals across the river by the equal-discharge-increment (EDI) method. Bed material samples are collected at 20 verticals. The suspended sediment samples and bed material samples are analyzed for particle size distribution. Reference 6 contains discussions of these samplers and the EDI method.

Water temperature has been measured weekly since October 1951. Daily turbidity has been measured throughout the period of sediment record (April 1948 to the present) by personnel at the City of St. Louis Howard Bend water treatment plant on the Missouri River (mile 36.6) and by personnel at the East St. Louis water treatment plant on the Mississippi River (mile 178.2); these turbidity readings are used to define the concentration curve for St. Louis on those days when no suspended sediment samples are taken (discussed under "Data Reduction Procedures").

The gaging station is on the Eads Highway and railroad bridge (mile 180.0). Although gaging at St. Louis dates to 1843, only gage-height data were obtained from 1843 to 1845 and from January 1861 to 1866. The period of record of discharge computations is from 1866 to 1927 (intermittent) and 1928 to the present. The tabulation below lists the devices used for gaging, recording, and transmitting data in the vicinity of the St. Louis gage:

Period	Device Used
Mississippi River Survey	
1843 - 1845	Staff gage
Mississippi River Commission (mile 179.6)	
January 1861 - 30 June 1928	Staff gage

Period	Device Used
U.S. Engineer Office, St. Louis (mile 179.6) (now U.S. Army Engineer District, St. Louis (SLD))	
1 July 1928 - September 1981	Staff gage in three sections
U.S. Weather Bureau (now National Weather Service (mile 180.0))	
1872 - 14 December 1934	Staff gage
14 December 1934 - 5 January 1953	Automatic water-stage telerecorder
5 January 1953 - September 1981	Stevens Type T-4 Telemark gage
USGS (mile 180.0)	
16 March 1933 - 5 May 1934	Staff gage in three sections (property of SLD)
5 May 1934 - 10 December 1952	Stevens continuous water-stage recorder
11 October 1935 - September 1981	Veatch patent tape gage; later replaced by Type A wire-weight gage
10 December 1952 - September 1981	Stevens A-35 recorder
2 October 1973 - September 1981	Fisher-Porter analog to digital recorder (1-hr intervals)
February 1976 - September 1981	Geostationary orbital earth satellite platform to transmit data to satellite every 15 minutes.

Laboratory Sample Analysis

Sediment analysis is the responsibility of the USGS Missouri District. The weekly samples collected on the second and fourth verticals (station No. 845 and No. 1524) are taken to the USGS Soils Laboratory in Rolla, Missouri. Suspended-sediment concentration analyses are run on each sample, and these values are later mathematically composited to obtain a single set of values for one day of sampling. The procedures used to analyze sediment samples are discussed in Reference 6.

Data Reduction Procedures

Computations of suspended sediment loads are made by hand. To calculate the suspended sediment load when no samples are taken, the weighted mean turbidity is used. The turbidity is computed by multiplying the value measured at the

Howard Bend treatment plant by the difference between the discharge at the Alton, Illinois, gaging station and the discharge at St. Louis, allowing a 1-day time lag between Howard Bend and the St. Louis station. Turbidity at the East St. Louis water treatment plant is then multiplied by the discharge at Alton, and the sum of these two determinations is divided by the discharge at the St. Louis station to compute the weighted mean turbidity.

Sediment concentrations on days of sampling are used to derive a coefficient related to the weighted mean turbidity for that day. A graph can then be constructed relating sediment concentration to the weighted mean turbidity for those days when samples are not taken. Concentrations measured on the two verticals are used for those days when samples are taken. Daily suspended sediment loads are computed by multiplying the product of the mean concentration in the cross section and the water discharge by 0.0027. Reference 16 contains a discussion of the data reduction procedures.

Data Reporting Procedures

The intermittent discharge measurements collected from 1866 through 1927 and the daily discharge measurements collected from 1928 through 1944 are in reports of the Mississippi River Commission. From 1933 to 1961, daily discharge values were published annually in References 14 and 17, and since 1961, these data have been published in References 18, 17, and 15. Daily temperatures and sediment loads were published prior to 1961 in Reference 4, and since 1961, these data have been published in Reference 2. A sample of the sediment data is shown in Table 4. Daily values for temperature and discharge are added periodically to the Environmental Protection Agency's STORET System by the USGS personnel at Reston, Virginia. These values are also part of the USGS Water Resources Division's Water Quality Files.

General Information

The stream sediment and gaging records for this station are considered to be very reliable. A number of analytical studies have been performed using these data (e.g. Reference 19).

Further information on this station can be obtained from: U.S. Department of the Interior, Geological Survey, Water Resources Division, Mail Stop 200, 1400 Independence Road, Rolla, Missouri 65401.

Figure 17 -- Sediment Sample Collection Location for Mississippi River at St. Louis, Missouri

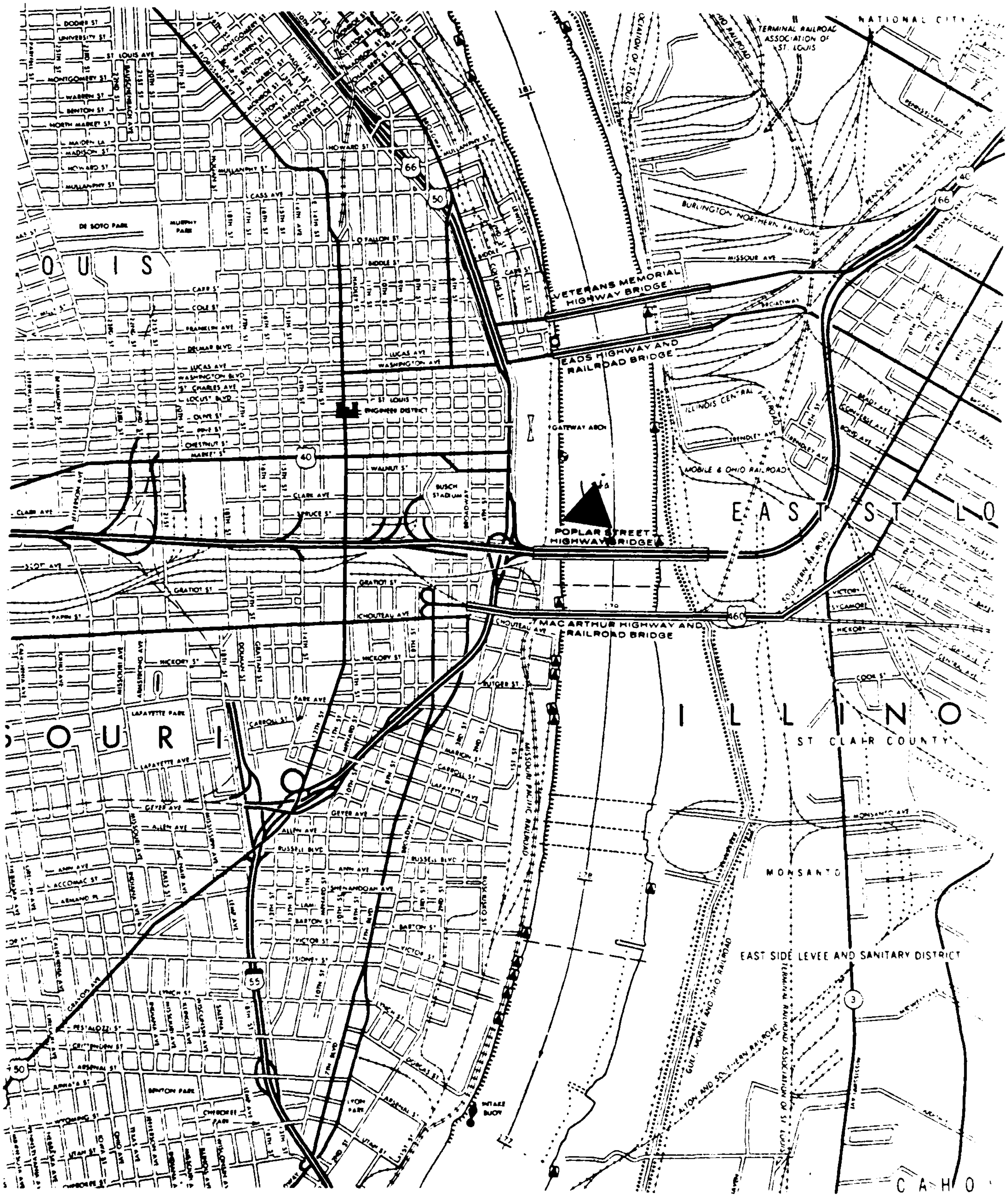


TABLE 4 -- Example of Sediment Data For St. Louis, Missouri (Source: Water Resources Data for Missouri, 1974, USGA, Rolla, Missouri)

MISSISSIPPI RIVER MAIN STEM

07010000 MISSISSIPPI RIVER AT ST. LOUIS, MO.--Continued

SUSPENDED-SEDIMENT DISCHARGE, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

	OCTOBER			NOVEMBER			DECEMBER		
DAY	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)
1	361000	983	958000	245000	280	185000	290000	258	202000
2	387000	1600	1670000	246000	267	177000	270000	262	191000
3	400000	1260	1360000	239000	254	164000	254000	292	200000
4	417000	1050	1180000	233000	232	146000	255000	308	212000
5	432000	887	1030000	225000	228	139000	302000	300	245000
6	443000	809	968000	211000	246	140000	372000	319	320000
7	447000	970	1170000	205000	254	141000	408000	552	608000
8	435000	737	866000	212000	238	136000	417000	635	715000
9	394000	704	749000	213000	238	137000	382000	708	730000
10	318000	612	525000	202000	219	119000	329000	719	639000
11	269000	551	400000	196000	237	125000	282000	716	545000
12	251000	445	302000	190000	202	104000	251000	447	303000
13	271000	289	211000	185000	200	99900	237000	356	228000
14	373000	239	241000	179000	257	124000	224000	298	180000
15	390000	477	502000	184000	222	110000	220000	240	143000
16	383000	924	956000	179000	272	131000	204000	216	119000
17	386000	890	928000	176000	277	132000	187000	217	110000
18	399000	962	1040000	178000	244	117000	168000	220	99800
19	409000	990	1090000	171000	240	111000	168000	184	83500
20	405000	536	586000	164000	235	104000	157000	156	66100
21	397000	654	701000	179000	235	114000	133000	162	58200
22	390000	675	711000	185000	253	126000	133000	158	56700
23	369000	519	517000	210000	221	125000	149000	190	76400
24	333000	428	385000	241000	245	159000	160000	142	61300
25	299000	405	327000	261000	366	258000	187000	137	69200
26	279000	379	286000	278000	914	686000	257000	185	128000
27	266000	496	356000	291000	716	563000	280000	366	292000
28	262000	339	240000	299000	458	370000	292000	365	288000
29	260000	331	232000	312000	347	292000	292000	323	255000
30	246000	283	188000	305000	322	265000	274000	430	318000
31	245000	281	186000	--	--	--	253000	444	303000
TOTAL	916000	--	20861000	6594000	--	5599900	7767000	--	7845200

	JANUARY			FEBRUARY			MARCH		
DAY	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)
1	215000	512	297000	468000	934	1180000	279000	435	328000
2	200000	459	248000	451000	858	1040000	270000	402	293000
3	190000	387	199000	427000	807	930000	266000	341	245000
4	175000	372	176000	407000	624	686000	265000	281	201000
5	160000	338	146000	384000	624	647000	264000	258	184000
6	155000	277	116000	358000	570	551000	275000	277	206000
7	150000	209	84600	326000	479	422000	294000	264	210000
8	145000	174	68100	287000	504	391000	313000	327	276000
9	141000	181	68900	269000	478	347000	319000	523	450000
10	146000	127	50100	260000	387	272000	319000	493	425000
11	140000	205	77500	248000	340	228000	329000	398	354000
12	123000	136	45200	230000	1310	814000	390000	483	509000
13	120000	131	42400	229000	1140	705000	437000	682	805000
14	126000	133	45200	231000	1120	699000	462000	774	965000
15	130000	130	45600	229000	690	427000	466000	896	1130000
16	132000	128	45600	225000	674	409000	458000	1050	1300000
17	134000	134	48500	217000	441	258000	443000	720	861000
18	160000	151	65200	211000	265	151000	424000	538	616000
19	212000	304	174000	218000	262	154000	409000	478	528000
20	264000	448	319000	249000	266	179000	391000	433	457000
21	330000	756	674000	290000	491	384000	371000	416	417000
22	368000	779	774000	311000	876	736000	342000	380	351000
23	395000	808	862000	323000	671	585000	316000	364	311000
24	408000	814	897000	338000	496	453000	301000	285	232000
25	399000	944	1020000	342000	389	359000	291000	268	211000
26	381000	858	883000	322000	502	436000	276000	287	214000
27	396000	816	872000	302000	715	583000	265000	281	201000
28	454000	792	971000	287000	631	489000	258000	292	203000
29	482000	873	1140000	--	--	--	251000	304	206000
30	482000	972	1260000	--	--	--	247000	334	223000
31	477000	898	1160000	--	--	--	248000	283	189000
TOTAL	7790000	--	12874900	8439000	--	14515000	239000	--	13101000

Meramec River near Eureka, Missouri

SOURCE: U.S. Geological Survey Files

Station Identification

OWDC No.: 07457

Agency Station No.: 07019000

Latitude/Longitude: 383020/903530

Agency reporting to OWDC: U.S. Geological Survey

Drainage Area: 3,788 square miles

River mile: 34.6 (the Meramec River enters the Mississippi River at river mile 160.7 where mile 0 is at the confluence of the Mississippi and Ohio Rivers; established by the Corps of Engineers in 1930).

Site Description

The Meramec gaging station is located on the right bank of the river, 44 feet upstream from the north access roadway bridge (old U.S. Highway 66) of Interstate 44, 2 miles east of Eureka, 3 miles downstream from Big River (Figure 18). A stationary sediment sampler for the daily single vertical is located on the upstream side of the bridge. The streambed is composed of cobbles and gravel. The right bank is high and rocky while the left bank is wooded and subject to overflow at a river stage of 24 feet. The discharges of record (August 1921 to October 1981) are: maximum - 120,000 cfs (1945); mean - 3,000 cfs; minimum - 196 cfs (1936). The estimated daily sediment loads of record (February 1969 to September 1970, October 1980 to May 1981) are: maximum - 175,000 tons/day (1969); minimum - 3.2 tons/day (1980).

Station Chronological Record

Water-discharge records began on August 26, 1903. At this time the gage was located on the highway bridge, 200 feet upstream from the present location. On January 16, the gage was moved to its present location on the Highway 66 bridge. Sampling for suspended sediment and particle size of suspended sediment and bed material occurred between February 1969 and September 1970 for a water-resources study in the greater St. Louis area. Daily suspended sediment sampling began on August 14, 1980, with periodic particle size analyses of suspended material, bedload, and bed material. All data collection has been the responsibility of the USGS, Missouri District.

Sample and Data Collection Procedures

Samples for suspended sediment, particle size, and bed material were collected from February 1969 to September 1970, and again in August 1980, by USGS personnel according to procedures discussed in reference 6. Daily depth-

integrated samples are collected from a stationary sampling station using a US D-74. Once a month the complete cross section is sampled by the equal-width-interval (EWI) method or equal-discharge-interval (EDI) method discussed in reference 6 using the US P-61, US D-74, or the US DH-48 sediment sampler. The monthly samples are used along with the daily single vertical samples and daily river stage to obtain an average daily suspended sediment concentration (Reference 16). One bedload sample was collected using a Helly-Smith bedload sampler. An explanation of the samplers used may be found in reference 21. To date, not enough data has been collected throughout the possible ranges of discharge to estimate suspended-sediment loads.

Laboratory Sample Analysis

During the period February 1969 to September 1970, all sediment laboratory work was performed by the USGS Sedimentation Laboratory at Iowa City, Iowa, following procedures discussed in reference 22. After August 1980, suspended sediment concentration analyses were performed by USGS Sediment Laboratory at Rolla, MO. Particle-size analyses continued to be performed at Iowa City, Iowa. A dispersing agent is added to suspended material during analysis, while distilled water is used when analyzing bedload and bed material. The size classes analyzed for are 0.002, 0.004, 0.008, 0.016, 0.062, 0.125, 0.25, 0.50, 1.0, 2.0, 4.0, 8.0, 16.0, 32.0, and 64.0 millimeters in diameter.

Data Reduction Procedures

The sediment records will be computed using standard USGS methods as discussed in reference 16. The complete river stage hydrograph is plotted, the suspended sediment data is evaluated and plotted with the stage hydrograph, the suspended sediment curve is drawn from plotted points using the stage hydrograph as a guide, then the daily suspended sediment values are taken from this graph and stored in the computer. The daily sediment discharge is calculated from the daily suspended sediment and daily discharge values.

Data Reporting Procedures

Daily and monthly sediment discharge and daily suspended sediment concentrations along with periodic particle size analyses of the suspended sediment and bottom material will be published in "Water Resources Data for Missouri" for each water year. Table 5 is an example.

General Information

Information concerning this sediment sample collection station can be obtained from: District Chief, U.S. Geological Survey, Water Resources Division, Mail Stop 200, 1400 Independence Road, Rolla, Missouri 65401.

Figure 18 -- Sediment Sample Collection Location for Meramec River near Eureka, Missouri

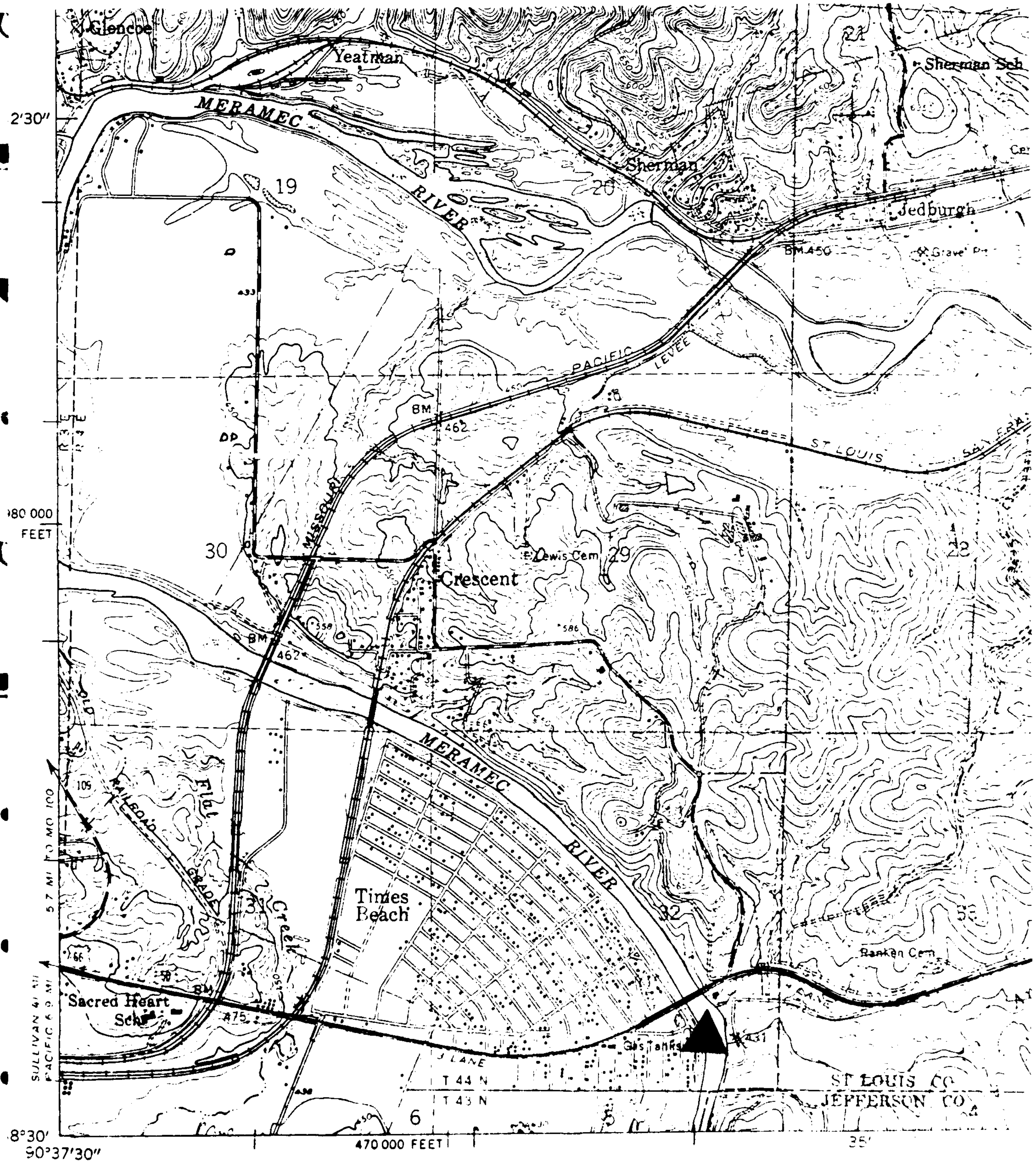


TABLE 5 -- Example of Sediment Data for Meramec River near Eureka, Missouri

MERAMEC RIVER BASIN

07019000 MERAMEC RIVER NEAR EUREKA, MO.

LOCATION.--Lat 38°30'20", long 90°35'30", in SE 1/4 sec.3., T.44 N., R.4 E., St. Louis County, at gaging station on right bank 44 ft upstream from north access road of U.S. Highway I-44, 2 miles east of Eureka, 3 miles downstream from Big River, and at mile 34.6.
DRAINAGE AREA.--3,788 sq mi.
PERIOD OF RECORD.--Sediment records: February 1969 to September 1970.

SUSPENDED-SEDIMENT DISCHARGE, WATER YEAR OCTOBER 1969 TO SEPTEMBER 1970

DAY	OCTOBER MEAN DISCHARGE (CFS)	OCTOBER MEAN CONCEN-TRATION (MG/L)	OCTOBER SEDIMENT DISCHARGE (TONS/DAY)	NOVEMBER MEAN DISCHARGE (CFS)	NOVEMBER MEAN CONCEN-TRATION (MG/L)	NOVEMBER SEDIMENT DISCHARGE (TONS/DAY)	DECEMBER MEAN DISCHARGE (CFS)	DECEMBER MEAN CONCEN-TRATION (MG/L)	DECEMBER SEDIMENT DISCHARGE (TONS/DAY)
1	884	54	129	1150	32	99	888	52	125
2	867	54	126	1160	34	106	869	52	122
3	829	54	121	1200	36	117	869	52	122
4	804	54	117	1340	40	145	860	52	121
5	783	54	114	1320	40	143	869	52	119
6	765	54	112	1230	38	126	853	52	120
7	781	54	114	1170	37	117	926	52	130
8	783	54	114	1120	37	112	1010	52	142
9	767	54	112	1090	38	112	1180	55	175
10	751	54	109	1060	39	112	1640	61	237
11	915	68	168	1040	40	112	1860	65	323
12	1490	107	430	1030	41	114	1700	60	275
13	3500	305	2880	1020	42	116	1580	57	243
14	5120	417	5760	997	43	116	1490	51	205
15	6980	483	9100	974	44	116	1420	46	176
16	4860	424	5560	954	45	116	1360	44	162
17	2880	407	3130	968	46	118	1290	42	146
18	2320	245	1530	956	47	121	1270	42	144
19	2330	84	528	955	48	124	1210	36	118
20	2080	74	416	956	49	126	1110	30	90
21	2520	80	544	956	50	129	1080	25	73
22	2590	81	566	957	51	132	1050	25	71
23	2080	76	427	968	52	136	1040	25	70
24	1810	72	352	969	52	136	1010	25	68
25	1620	62	271	966	52	136	1010	25	68
26	[illegible]	51	205	962	52	135	995	24	65
27	1380	41	153	967	52	133	983	23	61
28	1290	32	111	925	52	130	986	22	59
29	1200	20	65	911	52	128	992	21	56
30	1160	24	75	898	52	126	1020	22	61
31	1150	28	87	--	--	--	1080	23	67
TOTAL	58779	--	33526	31127	--	3689	35262	--	4014

DAY	JANUARY MEAN DISCHARGE (CFS)	JANUARY MEAN CONCEN-TRATION (MG/L)	JANUARY SEDIMENT DISCHARGE (TONS/DAY)	FEBRUARY MEAN DISCHARGE (CFS)	FEBRUARY MEAN CONCEN-TRATION (MG/L)	FEBRUARY SEDIMENT DISCHARGE (TONS/DAY)	MARCH MEAN DISCHARGE (CFS)	MARCH MEAN CONCEN-TRATION (MG/L)	MARCH SEDIMENT DISCHARGE (TONS/DAY)
1	1160	24	75	1630	29	128	1950	40	211
2	1260	25	85	1580	28	119	1950	40	211
3	1300	26	91	1480	27	108	6000	56	605
4	1280	25	86	1400	26	98	7040	109	2070
5	1260	25	85	1380	24	89	7650	118	2440
6	1140	25	77	1350	22	80	6130	100	1660
7	1030	25	70	1330	21	75	4520	92	1120
8	921	26	65	1330	21	75	3640	80	786
9	993	27	72	1330	21	75	3130	65	549
10	1020	28	77	1360	21	77	2760	58	432
11	1030	29	81	1380	21	78	2670	56	373
12	1070	30	87	1340	21	76	2310	53	331
13	1100	36	107	1320	20	71	2210	51	304
14	1060	35	100	1320	20	71	2130	50	288
15	1030	34	95	1290	19	66	2080	50	281
16	984	32	85	1270	19	65	2080	50	281
17	930	32	80	1240	19	64	2160	51	297
18	921	32	80	1280	19	66	2270	58	355
19	948	32	82	1410	20	76	2570	72	500
20	1110	32	96	1810	25	122	3710	86	861
21	1090	32	94	1910	30	155	5700	100	1540
22	1010	32	87	1970	35	186	6850	105	1940
23	1130	32	98	1960	35	185	6050	100	1630
24	1260	32	109	2040	40	222	5090	93	1280
25	1310	32	113	2170	45	264	4710	90	1140
26	1350	32	117	2230	52	313	6890	105	1950
27	1490	32	129	2220	52	312	9620	124	3220
28	1740	32	150	2080	45	253	9330	119	3000
29	1800	32	156	--	--	--	6680	100	1800
30	1770	31	148	--	--	--	4820	115	1500
31	1730	30	140	--	--	--	4040	130	1420
TOTAL	37227	--	3017	44430	--	3569	136540	--	36775

Kaskaskia River near Venedy Station, Illinois

SOURCE: U.S. Geological Survey Files

Station Identification

OWDC No.: 27789

Agency Station No.: 05594100

Latitude/Longitude: 382702/893739

Agency reporting to OWDC: U.S. Geological Survey

Drainage area: 4,393 square miles

River mile: 57.2 from the confluence of the Illinois and Mississippi. The confluence is at Mississippi River mile 117.6 (mile 0 is at the confluence of the Mississippi and Ohio Rivers; established by the Corps of Engineers in 1930).

Site Description

Beginning in May 1975, suspended sediment samples have been collected from the State Highway 160 and 177 bridge, 1 mile northwest of Venedy Station, 2.5 miles downstream of Sugar Creek and 4 miles west of Okawville (Figure 19). Streamflow is partially regulated by Carlyle Reservoir about 35 miles upstream. The daily discharges of record (1969 to September 1981) are: maximum - 41,800 cfs; and minimum - 54 cfs. The maximum, minimum, and mean daily sediment loads for the period 4/80 to 9/81 are maximum - 19,700 tons/day, minimum - 1.9 tons/day, and mean - 970 tons/day. Not enough data are presently available to estimate sediment loads.

Station Chronological Record

This site was established by the Illinois District of the Water Resources Division of the USGS as a NASQAN (national stream quality accounting network station) station in water year 1975. Since that time, suspended sediment samples have been collected routinely on a monthly basis. In May 1980, daily sampling was started with increased sampling frequency following rises in the stream.

Sample and Data Collection Procedures

Depth-integrated water samples for suspended sediment (reference 6) as well as other NASQAN parameters have been collected by USGS personnel using sediment samplers such as the US DH-76 and US DH-59. In May 1980, the observer was supplied with a US DH-59. A stationary sampling station was installed on the bridge in 1980, equipped with a US P72 (aluminum US P61). A brief but pertinent explanation of these samplers may be found in reference 23. Depending on flow conditions, the USGS personnel may use any one of these samplers. The observer

always takes samples from a fixed location. In order to determine the mean stream sediment concentrations and the relationship between the samples collected from the observer location and the mean concentration, multi-vertical depth-integrated samples are collected on a six week basis. These samples are analyzed for concentration and for particle size distribution. Following selected large storms, special data collection trips are undertaken to collect suspended sediment, bedload (mainly coarse material skipping and rolling along the streambed) and bed material. Bedload is collected using the Helley-Smith bedload sampler and bed material is gathered using a US BM54 or a US BMH60.

Laboratory Sample Analysis

All sediment sample analysis has been performed by the USGS sedimentation laboratory at Iowa City, Iowa, following procedures discussed in reference 10.

Data Reduction Procedures

All sediment records since May 1980 will be computed using standard USGS methods as discussed in references 16 and 25. The complete river stage hydrograph is plotted, all lab data is evaluated for consistency and validity, all valid lab data is plotted along the stage hydrograph, storm periods are drawn and computed, all the daily mean concentrations are entered into the computer, the computer calculates the nonstorm daily loads, the storm period concentrations and loads are enterd and a printout of mean daily discharge, the corresponding mean daily concentration and the corresponding daily load for the February to the end of September period is retrieved, checked and published.

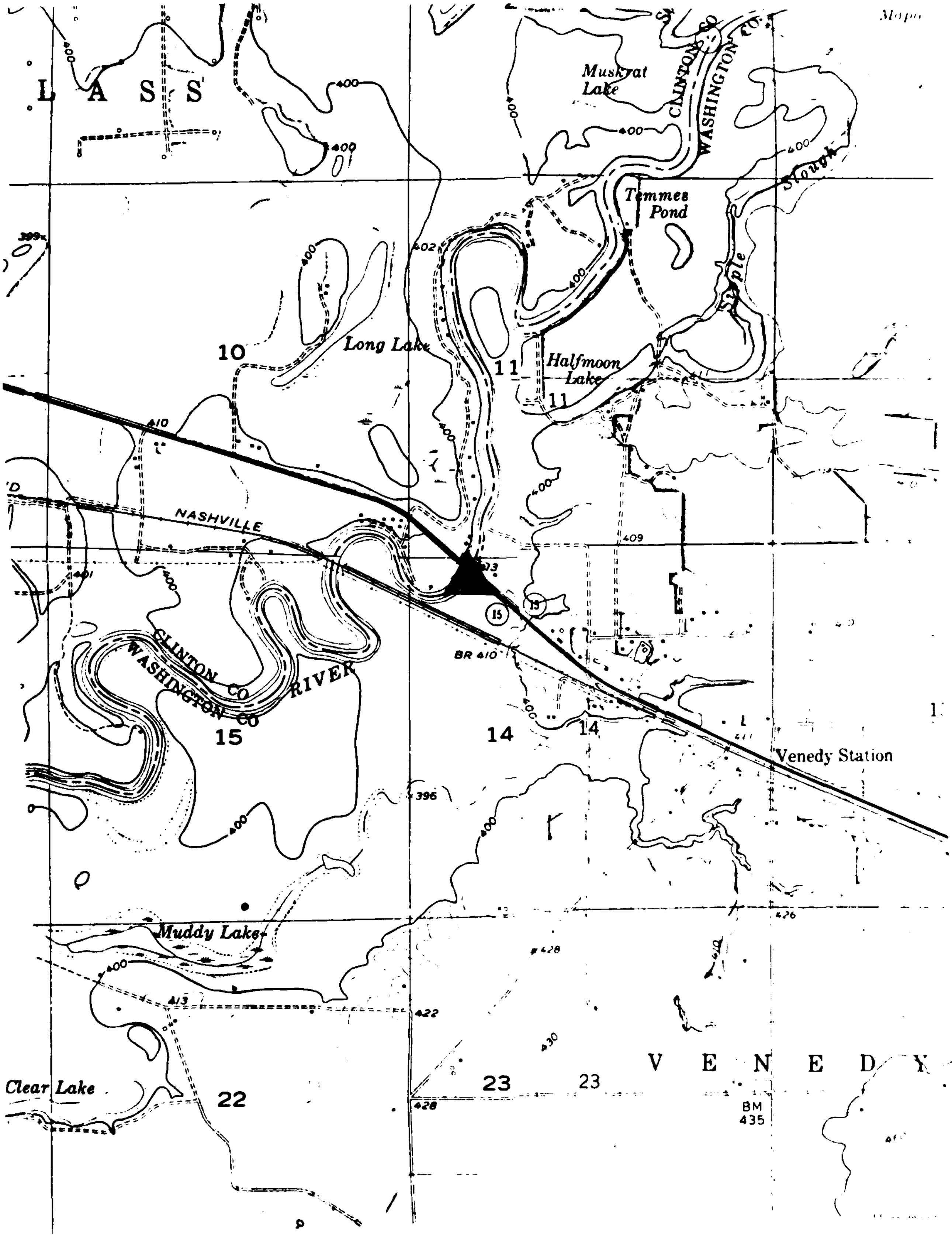
Data Reporting Procedures

Daily and monthly sediment discharge, and daily concentrations will be published in "Water Resources Data for Illinois" for water year 1980 (see Table 6 for an example of format).

General Information

Information concerning this sediment sample collection station can be obtained from: District Chief, U.S. Geological Survey, Water Resources Division, Champaign County Bank Plaza, 4th Floor, 102 E. Main St., Urbana, Illinois 61801.

Figure 19 -- Sediment Sample Collection Location for Kaskaskia River near Venedy Station, Illinois



Saline Creek near Minnith, Missouri

SOURCE: U.S. Geological Survey Files

Station Identification

OWDC No.: 24202

Agency Station No.: 07020270

Latitude/Longitude: 374916/900113

Agency reporting to OWDC: U.S. Geological Survey

Drainage area: 82.6 square miles

River mile: 22.6 miles from the confluence of Saline Creek and the Mississippi River. The confluence is at Mississippi River mile 110.5. (Mile 0 is at the confluence of the Mississippi and Ohio Rivers; established by the Corps of Engineers in 1930).

Site Description

This station is located at the Highway N bridge, 5.5 miles southwest of St. Marys and 2.5 miles northeast of Minnith (Figure 20). The streambed is mainly composed of sands with a mean particle size of 1 millimeter. The channel gradient at the gage is 4 feet per mile. The discharges of record (June 1980 to September 1981) maximum - 1,260 cfs (1981); mean - 30 cfs; minimum - 3.3 cfs (1980). The suspended sediment loads of record (July 1980 to September 1981) are: maximum - 772 tons/day (1981); minimum - 0.03 tons/day (1980).

Station Chronological Record

A low-flow partial record station was established at the site during April 1968. Various discharge measurements were made to define the low flow characteristics of the creek. During July 1980, a water stage recorder was installed and suspended sediment and discharge measurements were made on a routine basis. A sediment sampler also was installed at this time on the downstream side of the bridge where an observer takes daily sediment samples.

Sample and Data Collection Procedures

Sampling for suspended sediment, particle size, and bed material began July 3, 1980, by U.S. Geological Survey personnel following procedures discussed in reference 6. Daily depth-integrated samples are collected from a stationary sampling station using a US D-74. Once a month the complete cross section is sampled by the equal-transit-rate (ETR) method (equal spacing between verticals) discussed in reference 6 using a US P-61, US D-74, or a US DH-48 suspended sediment sampler. The monthly samples are used along with the daily

single vertical samples and daily river stage to obtain an average daily suspended sediment concentration (reference 16). One bedload sample was collected using a Helly-Smith bedload sampler. An explanation of the samplers used may be found in reference 21.

Laboratory Sample Analysis

Suspended sediment concentration analysis is done by the U.S.G.S. laboratory at Rolla, Missouri. Particle size analysis of bedload is done by the U.S.G.S. sediment laboratory at Iowa City, Iowa, following procedures discussed in reference 22. Distilled water is used when analyzing bedload. The size classes analyzed for are 0.25, 0.50, 1.0, 2.0, 4.0, 8.0, 16.0, 32.0, and 64.0 millimeters in diameter.

Data Reduction Procedures

The sediment records will be computed using standard U.S. Geological Survey methods as discussed in reference 16. The complete river stage hydrograph is plotted, the suspended sediment data are evaluated and plotted with the stage hydrograph, the suspended sediment curve is drawn from plotted points using the stage hydrograph as a guide, then the daily suspended sediment values are taken from this graph and stored in the computer. The daily sediment discharge is calculated from the daily suspended sediment and daily discharge values.

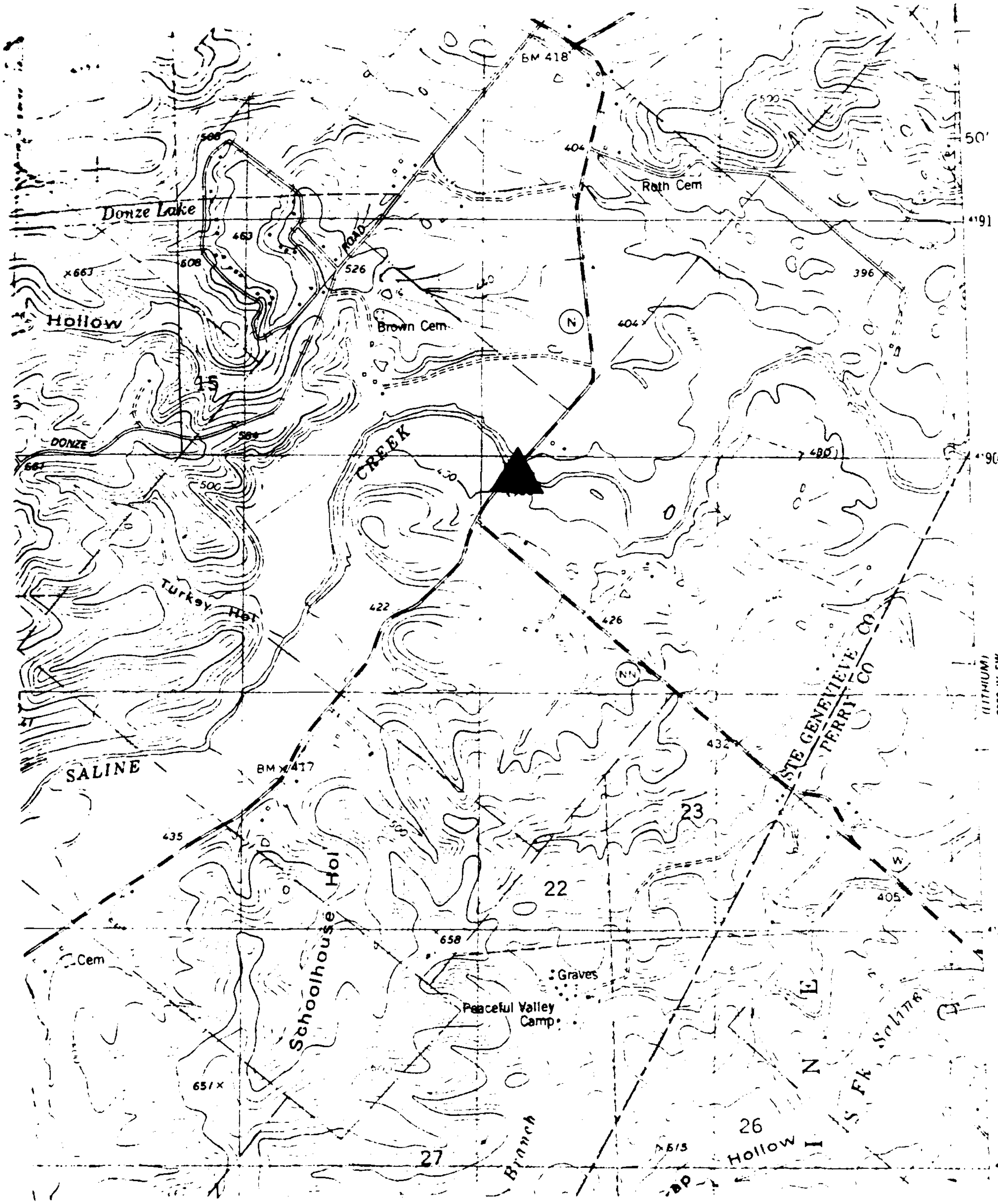
Data Reporting Procedures

Daily and monthly sediment discharge and daily suspended sediment concentrations, along with periodic particle size analyses of suspended sediment and bottom material, will be published in "Water Resources Data for Missouri" for each water year.

General Information

Information concerning this sediment sample-collection station can be obtained from: District Chief, U.S. Geological Survey, Water Resources Division, Mail Stop 200, 1400 Independence Road, Rolla, Missouri 65401.

Figure 20 -- Sediment Sample Collection Location for Saline Creek near Minnith, Missouri



Mississippi River at Chester, Illinois

SOURCE: U.S. Geological Survey Files

Station Identification

OWDC No.: 07458

Agency Station No.: 07020500

Latitude/Longitude: 375410/895010

Agency reporting to OWDC: U.S. Geological Survey

Drainage area: 708,600 square miles

River mile: 109.9 (Mile 0 is at the confluence of the Mississippi and Ohio Rivers; established by the Corps of Engineers in 1930).

Site Description

This station is located at the bridge crossing the Mississippi River at Chester, Illinois (mile 109.9), connecting Missouri State Highway 51 to Illinois State Highway 150 (Figure 21). The stream gaging station is on the downstream side of the left pier of the main truss on the bridge. The gage is 8.1 miles downstream from Kaskaskia River. Discharge measurements are taken from the bridge. For river stages above 17 feet, flow occurs in Horse-Island Chute on the Missouri side of the Mississippi River. The streambed consists of silts and sands, and the channel gradient is approximately 0.5 foot per mile. The daily discharges of record (October 1927 to October 1981) are: maximum - 886,000 cfs (1947); mean - 183,200 cfs; minimum - 30,000 cfs (1937). The suspended sediment loads of record (August 1980 to October 1981) are: maximum - 2,410,000 tons (1981), minimum - 3,580 tons (1981).

Station Chronological Record

This station was established on May 26, 1891, by the U.S. Army, Corps of Engineers, who collected water-discharge data. On July 1, 1942, the U.S. Geological Survey took over operation of the gage. Daily suspended-sediment sampling and periodic sampling of particle size of suspended sediment and bed material started on May 20, 1980.

Sample and Data Collection Procedures

Sampling for suspended sediment, particle size, and bed material began May 1980 by USGS personnel according to procedures discussed in reference 6. Daily depth-integrated samples are collected from a stationary sampling station using a US P-61. Once a month the complete cross section is sampled by the equal-transit-rate (ETR) method (equal spacing between verticals) discussed in reference 6 using a US P-61. The monthly samples are used along with the daily single vertical samples and daily river stage to obtain an average daily

suspended sediment concentration (reference 16). Eight bed material samples have been obtained using a US BM-54 sampler. Four samples for suspended sediment particle size have been collected. An explanation of the samplers used may be found in reference 21.

Laboratory Sample Analysis

Suspended sediment concentration analysis is preferred by the U.S.G.S. laboratory at Rolla, MO. Particle-size analysis of suspended material and bed material are performed by the U.S.G.S. sediment laboratory at Iowa City, Iowa, following procedures discussed in reference 22. A dispersing agent is added to the suspended material during analysis while distilled water is used when analyzing bed material. The size classes analyzed for are 0.002, 0.004, 0.008, 0.016, 0.062, 0.125, 0.25, 0.50, 1.0, 2.0, 4.0, 8.0, 16.0, 32.0, and 64.0 millimeters in diameter.

Data Reduction Procedures

The sediment records will be computed using standard USGS methods as discussed in reference 16. The complete river stage hydrograph is plotted, the suspended sediment data are evaluated and plotted with the stage hydrograph, the suspended sediment curve is drawn from plotted points using the stage hydrograph as a guide, then the daily suspended sediment values are taken from this graph and stored in the computer. The daily sediment discharge is calculated from the daily suspended sediment and daily discharge values.

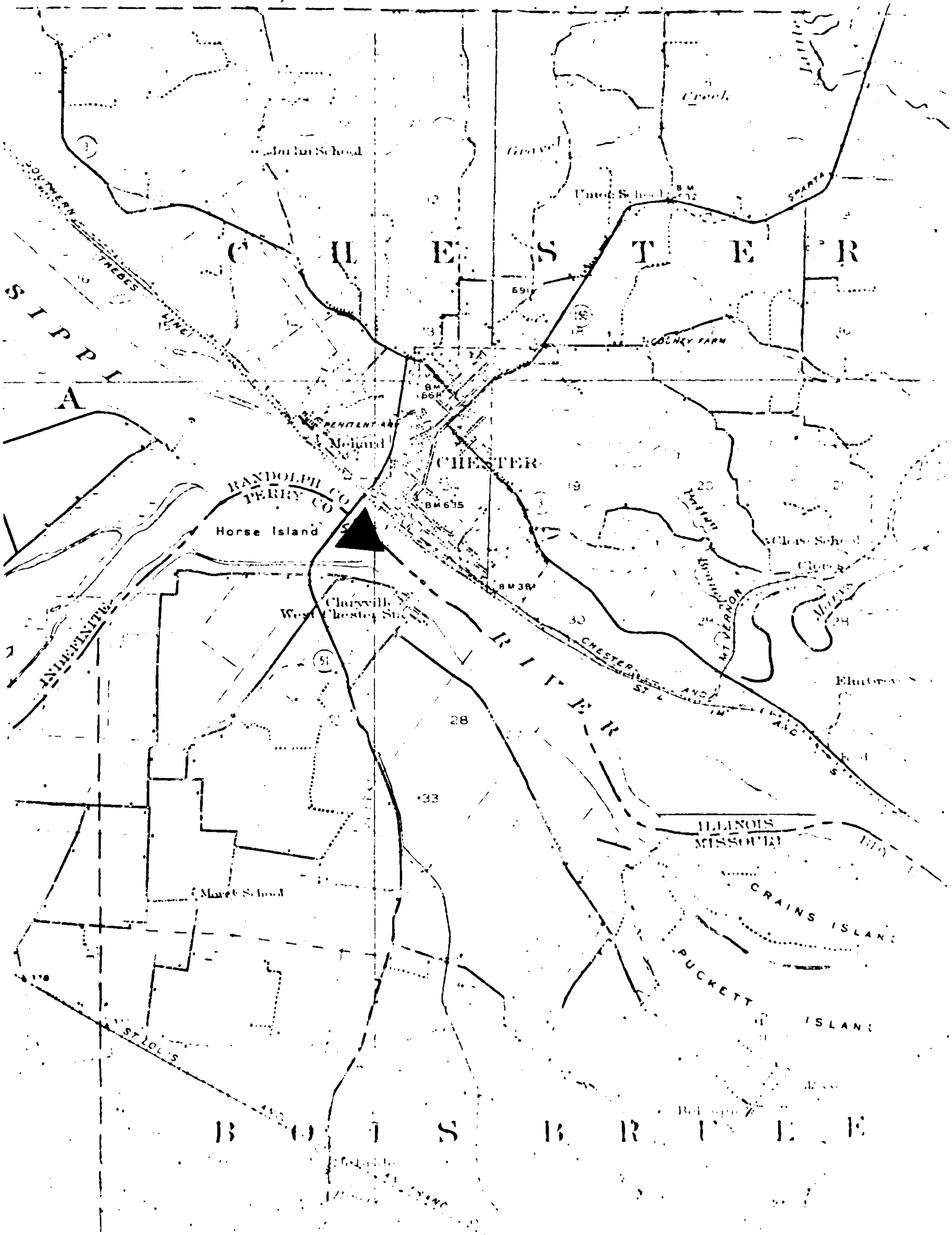
Data Reporting Procedures

Daily and monthly sediment discharge and daily suspended sediment concentrations along with periodic particle size analyses of the suspended sediment and bottom material will be published in "Water Resources Data for Missouri" for each water year.

General Information

Information concerning this sediment sample collection station can be obtained from: District Chief, U.S. Geological Survey, Water Resources Division, Mail Stop 200, 1400 Independence Road, Rolla, Missouri 65401.

Figure 21 -- Sediment Sample Collection Location for Mississippi River at Chester, Illinois



Big Muddy River at Murphysboro, Illinois

SOURCE: U.S. Geological Survey Files

Station Identification

OWDC No.: 08919

Agency Station No.: 05599500

Latitude/Longitude: 374455/892045

Agency reporting to OWDC: U.S. Geological Survey

Drainage area: 2,162 square miles

River mile: 36.0 (The Big Muddy River enters the Mississippi River at river mile 75.7 where mile 0 is at the confluence of the Mississippi and Ohio River; established by the Corps of Engineers in 1930).

Site Description

The Big Muddy gaging station (daily discharge record started in 1931) is located on the left bank just upstream from Lewis Creek, 0.1 mile upstream from the Gulf, Mobile and Ohio Railroad bridge (Figure 22). Monthly suspended sediment samples, collected as part of the NASQAN program, are taken from the Illinois State Highway 127 bridge, 1.5 mile upstream of the gaging station. The streambed is mud and gravel overlying bedrock. Streamflow is regulated by Rend Lake about 68 miles above the gage, and is affected by backwater from the Mississippi River. In order to accurately determine streamflow an auxiliary water stage recorder is located 7,700 feet upstream of the gage. By identifying the difference in stage between these two points the water surface slope is obtained and discharges within this reach are defined by a slope-stage-discharge relation. Discharges at both sites are assumed to be identical for a defined range in slope; beyond this range a correction factor has to be applied. The daily discharges of record are: maximum - 33,300 cfs; mean - 1,778 cfs; and a minimum of 4,400 cfs caused by reverse flow. The maximum, minimum, and mean daily sediment loads for the period 4/80 to 9/81 are maximum - 8,430 tons/day, minimum - 0.62 tons/day, and mean - 378 tons/day. Not enough data are presently available to estimate sediment loads.

Station Chronological Record

Suspended sediment sampling began on a monthly basis (part of NASQAN program) in June 1975 by USGS personnel. In March 1980, an observer was hired and daily sampling began with increased sampling frequency following storms. Sediment data are published in the annual USGS Water Resources Data for Illinois series.

Sample and Data Collection Procedures

Depth-integrated, suspended sediment samples, as well as samples for other water quality parameters, are collected monthly by USGS personnel. In March 1980, daily collection of suspended sediment was started by a USGS paid observer. The observer samples were from one fixed location at the bridge. In order to develop an understanding of the relationship between the sample concentrations collected at that one point and the mean concentration at that cross section, USGS personnel complete multi-vertical (gather samples from about 20 points) cross section during each routine visit (reference 6). The observer was equipped with a US DH-59 (for a description of samplers see reference 23) sampler. Observer collected samples are usually analyzed for suspended sediment concentration; however, if they are storm collected samples they may be analyzed for particle size. Under the NASQAN program, samples collected by USGS field men are analyzed for sand/fine determinations. After March 1980 these samples were analyzed for concentration (composite of a multi-vertical cross section) and particle size (also a composite of a multi-vertical cross section). Following large rainstorms, special field trips are conducted to gather bedload (very coarse material skipping and rolling along the streambed), suspended sediment, and bed material. Bedload is collected using the Helley-Smith Bedload Sampler and bed material is gathered using a US BM-54 or a US BMH-60.

Laboratory Sample Analysis

All sediment sample analysis has been performed by the USGS sedimentation laboratory at Iowa City, Iowa, following procedures discussed in reference 22.

Data Reduction Procedures

All sediment records since March 1980 will be computed using standard USGS methods as discussed in references 16 and 25. The complete river stage hydrograph is plotted, all lab data is evaluated for consistency and validity, all valid lab data is plotted along the stage hydrograph, storm periods are drawn and compute , all the daily mean concentrations are entered into the computer, the computer calculates the nonstorm daily loads, the storm period concentrations and loads are entered and a printout of mean daily discharge, the corresponding mean daily concentration and the corresponding daily load for the February to the end of September period is retrieved and published.

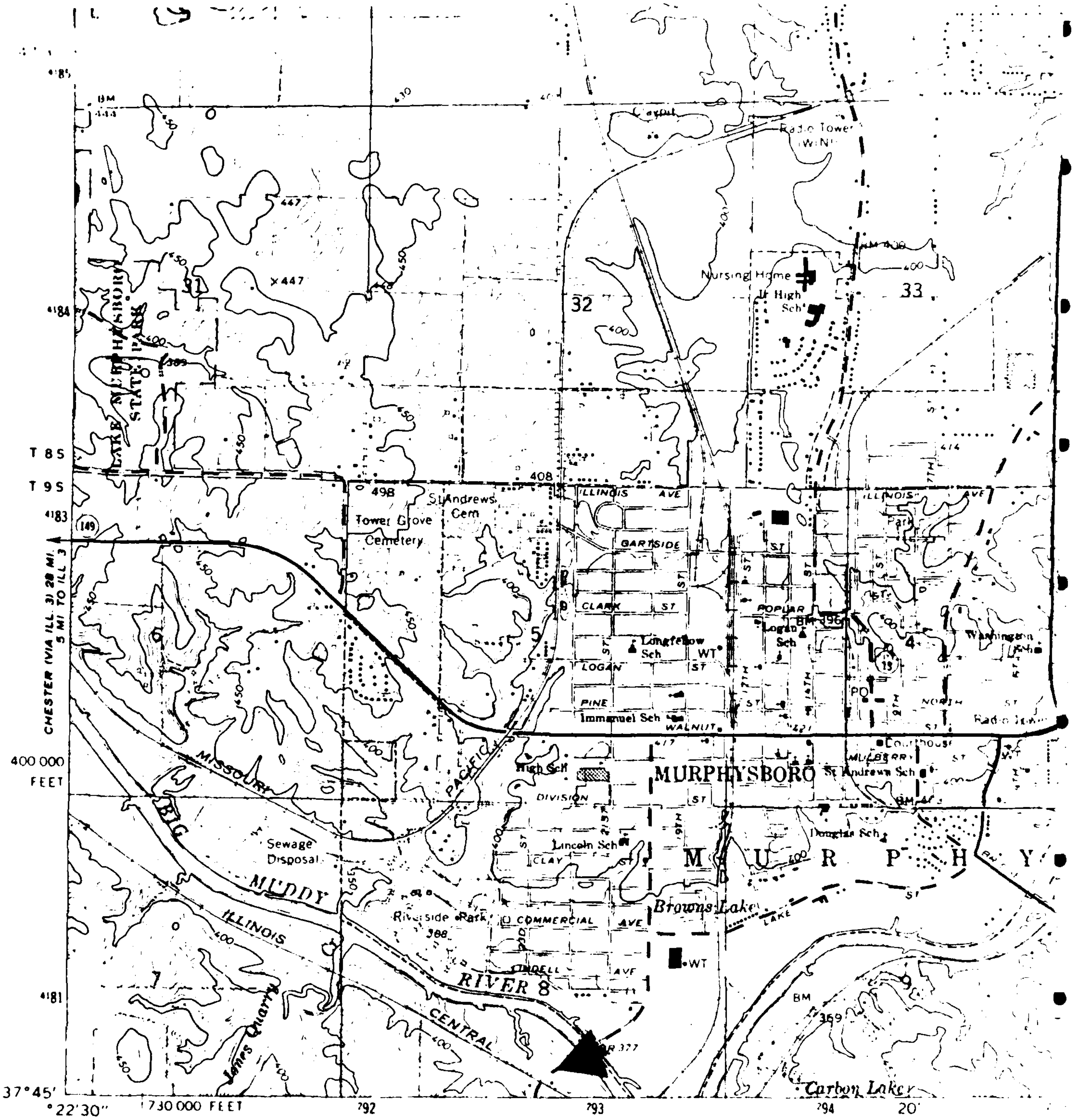
Data Reporting Procedures

Daily and monthly sediment discharge, and daily concentrations are published in "Water Resources Data for Illinois" for water year 1980.

General Information

Information concerning this sediment station can be obtained from: District Chief, U.S. Geological Survey, Water Resources Division, Champaign County Bank Plaza, 4th Floor, 102 E. Main St., Urbana, Illinois 61801.

Figure 22 -- Sediment Sample Collection Location for Big Muddy River at Murphysboro, Illinois



Mississippi River at Thebes, Illinois

SOURCE: U.S. Geological Survey Files

Station Identification

OWDC No.: 07461

Agency Station No.: 07022000

Latitude/Longitude: 371300/892750

Agency Reporting to OWDC: U.S. Geological Survey

Drainage area: 713,200 square miles

River mile: 43.7 (mile 0 is at the confluence of the Mississippi and Ohio Rivers; established by the Corps of Engineers in 1930).

Site Description

This station is located on the St. Louis Southern Railway Company bridge which crosses the Mississippi River at Thebes, Illinois, mile 43.7 (Figure 23). The stream gaging station is located on the third pier from the Illinois side of the St. Louis Southern Railway Company railroad bridge. The gage is 5.0 miles downstream from the Headwater Diversion Channel (Figure 18). During high stages the gage is affected by backwater from the Ohio River. A metal shed located in the middle of the bridge contains a power crane that the observer uses to collect sediment samples. Discharge measurements and sediment samples are obtained using a monorail car that is suspended under the bridge. The streambed consists of silts and sands, and the channel gradient is approximately 0.5 foot per mile. The daily discharges of record (October 1932 to September 1981) are: maximum - 893,000 cfs (1943); mean - 188,300 cfs; minimum - 23,400 cfs (1937). The suspended sediment loads of record (October 1980 to September 1981) are: maximum - 2,040,000 tons (1981); minimum - 2,530 tons (1981).

Station Chronological Record

This station was established on April 5, 1941, by the U.S. Geological Survey who collected daily water-discharge data. In January 1973, the USGS started collecting monthly samples of suspended sediment. Beginning October 17, 1976, the monthly suspended sediment samples also were analyzed for the percentage of material less than 0.062 millimeters in diameter (sand break). On May 20, 1980, daily suspended sediment sampling started, along with periodic sampling for particle size of suspended material and bed material.

Sample and Data Collection Procedures

Beginning January 1973 depth-integrated suspended sediment samples were collected monthly by USGS personnel. Sampling for suspended sediment, particle size and bed material began May 1980 according to procedures discussed in

reference 6. Daily depth-integrated samples are collected from a stationary sampling station using a US P-63. Once a month the complete cross section is sampled by the equal-transit-rate (ETR) method (equal spacing between verticals) discussed in reference 6 using a US P-61 or US P-63 monthly. The samples are used along with the daily single vertical samples and daily river stage to obtain an average daily suspended sediment concentration (reference 16). Six bed material samples have been obtained using a US BM-54 sampler. Four samples for suspended sediment particle size have been collected. An explanation of the samplers used may be found in reference 21.

Laboratory Sample Analysis

Suspended sediment concentration analysis is preferred by the U.S.G.S. laboratory at Rolla, Missouri. Particle size analysis of suspended material and bed material are performed by the U.S.G.S. sediment laboratory at Iowa City, Iowa, following procedures discussed in reference 22. A dispersing agent is added to the suspended material during analysis while distilled water is used when analyzing bed material. The size classes analyzed for are 0.002, 0.004, 0.008, 0.016, 0.062, 0.125, 0.25, 0.50, 1.0, 2.0, 4.0, 8.0, 16.0, 32.0, and 64.0 millimeters in diameter.

Data Reduction Procedures

The sediment records will be computed using standard USGS methods as discussed in reference 16. The complete river stage hydrograph is plotted, the suspended sediment data is evaluated and plotted with the stage hydrograph, the suspended sediment curve is drawn from plotted points using the stage hydrograph as a guide, then the daily suspended sediment values are taken from this graph and stored in the computer. The daily sediment discharge is calculated from the daily suspended sediment and daily discharge values.

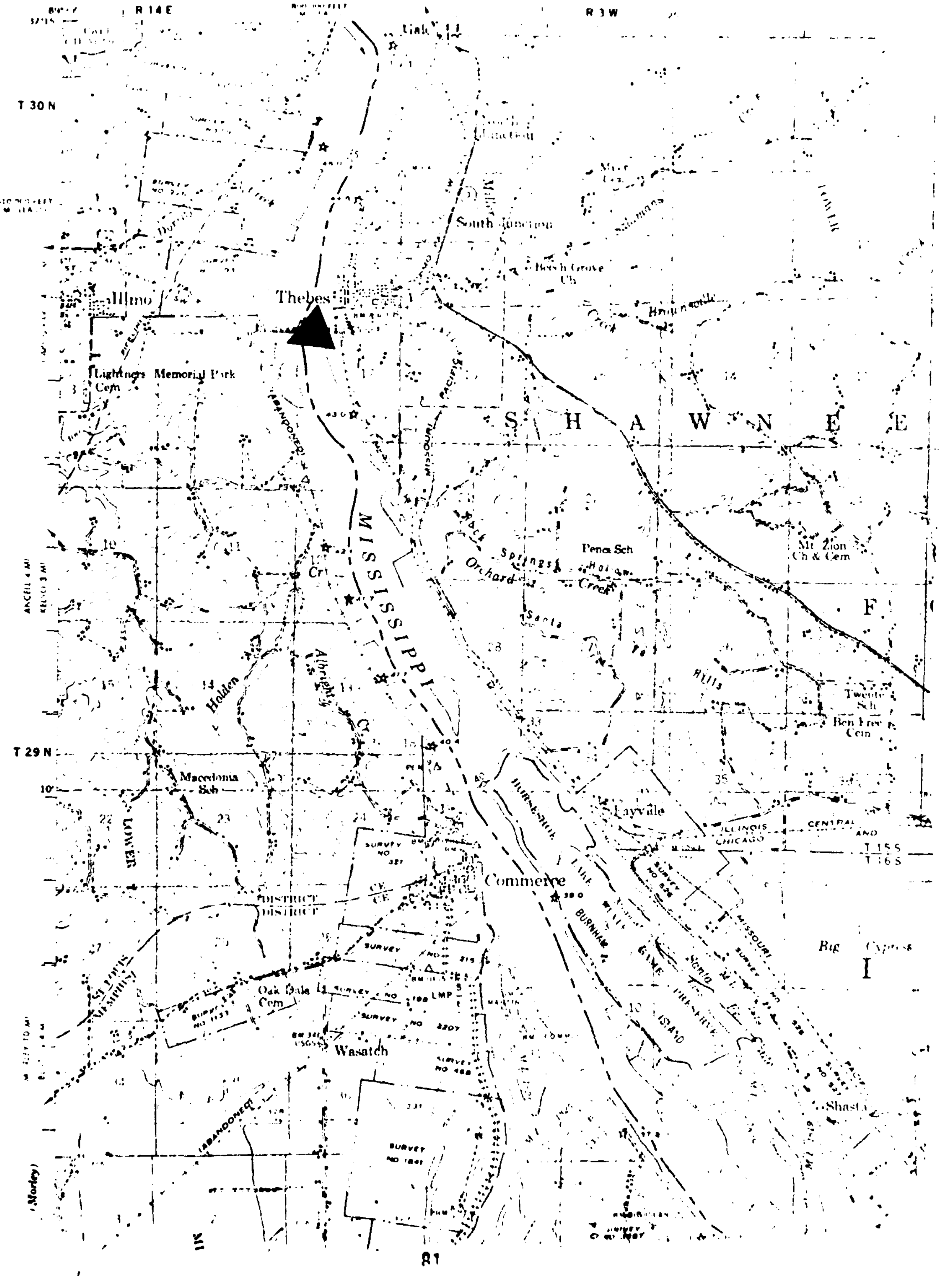
Data Reporting Procedures

Daily and monthly sediment discharge and daily suspended sediment concentrations along with periodic particle size analyses of the suspended sediment and bottom material will be published in "Water Resources Data for Missouri" for each water year.

General Information

Information concerning this sediment sample collection station can be obtained from: District Chief, U.S. Geological Survey, Water Resources Division, Mail Stop 200, 1400 Independence Road, Rolla, Missouri 65401.

Figure 23 -- Sediment Sample Collection Location for Mississippi River at Thebes, Illinois



III. FUNDED STUDIES

The GREAT III Erosion and Sediment Work Group initiated funding for: (1)Sediment Discharge Measurements, (2) Quantifying Flood Plain Deposition and Flood Plain Scour as Sediment Sources, and (3) Statistical Analysis of Sediment Data and Development of a Sediment Budget. Descriptions of these studies follow:

Sediment Gaging

Cooperative agreements for sediment measurements and analyses were drawn up between the St. Louis Corps of Engineers and the United States Geological Survey in Illinois and Missouri during 1980 and 1981. Gaging stations, streams, hydrologic units, and drainage areas are listed in downstream order in Table 6.

Daily suspended sediment concentration and load, particle size analyses of suspended sediment (approximately six samples per year), bed materials grain size classification (monthly samples during open water season), and bedload grain size classification and grain size distribution (approximately three rises per year) were done by the Illinois and Missouri U.S. Geological Surveys at the following locations (Figure 2).

SEDIMENT DATA COLLECTION GAGING RESPONSIBILITIES

Illinois	Missouri
Illinois River at Valley City, IL	Mississippi River at Alton, IL
Big Muddy River at Murphysboro, IL	Mississippi River at Chester, IL
Kaskaskia River at Venedy Station, IL	Mississippi River at Thebes, IL
	Salt River near Monroe City, MO
	Salt River near New London, MO
	Meramec River near Eureka, MO
	Saline Creek near Minnith, MO

TABLE 6 -- Sediment Gage Locations and Drainage Areas

GREAT III, EROSION AND SEDIMENT WORK GROUP, SEDIMENT STUDY
Saverton, Missouri, to Cairo, Illinois

Sediment Gages on Mississippi River	Major Tributary Confluence	Sediment Gages on Tributaries	Hydrologic Units [1/]	Drainage Area (Sq. Mi.)
Hannibal				137,300
	Salt River		07110005 (885 sq. mi.)	
			07110006 (1,209 sq. mi.)	
			07110007 (790 sq. mi.)	2,884 [2/]
		Monroe City, MO (2,230 sq. mi.)		
		New London, MO (2,480 sq. mi.)		
	@ Diversion Ditch			
	Bay Creek (176 sq. mi.)			
		Nebo, IL (161 sq. mi.)		
	Cuivre River		07110008	1,249
			07110004 (1,956 sq. mi.)	1,956
	Illinois River			28,906
		Valley City, IL (26,564 sq. mi.)		
			07110009 (1,634 sq. mi.)	1,634
Alton				171,500
	Missouri River			526,200
		Hermann, MO (524,200 sq. mi.)		
St. Louis				697,000
	Meramec River			3,980
		Eureka, MO (3,788 sq. mi.)		
			07140101 (634 sq. mi.)	634
			07140102 (2,150 sq. mi.)	
			07140103 (835 sq. mi.)	
			07140104 (974 sq. mi.)	3,959
	Kaskaskia River			5,801
		Venedy, IL (4,393 sq. mi.)		
	River Aux Vases			100
	Saline Creek			228
		Saline Creek Near Minnith (83 sq. mi.)		

TABLE 6 -- Continued

Sediment Gages on Mississippi River	Major Tributary Confluence	Sediment Gages on Tributaries	Hydrologic Units 1/	Drainage Area (Sq. Mi.
Chester				708,60
	Big Muddy River			2,38
		Murphysboro, IL (2,162 sq. mi.)		
Thebes				713,20
			07140105 (1,622 sq. mi.)	
			07140107 (1,218 sq. mi.)	2,84
	Mississippi River at Birds Point 2.0 miles above confluence with Ohio River			717,39
		Total Six Aggregated Areas (15,156 sq. mi.)		

1/ Corridor Hydrologic Units comprise 2.1 percent of the total drainage.

2/ Underlined numbers are study area subtotals.

The Illinois U.S. Geological Survey is also responsible for estimates of long-term sediment yields for Bay Creek near Nebo, Illinois. The Corps of Engineers has periodically collected suspended sediment samples since 1965. Discharge measurements have been made at Bay Creek, Nebo, Illinois, by the Illinois District USGS since 1939.

Quantifying Sediment Sources - Bank Erosion and Flood Plain Scour

A contract was let by the St. Louis Corps of Engineers to the University of Missouri, Institute of Water Research at Rolla, Missouri, for quantification of bank erosion along the Mississippi River and net flood plain erosion and deposition on the Mississippi River flood plain from Saverton, Missouri, to Cairo, Illinois. The high bank was mapped to quantify bank erosion and/or accretion (38).

Computer Analyses of Sediment Data

Storage analyses of sediment discharge data in a uniform and consistent manner was deemed desirable. To accomplish this task, the E&S Work Group decided to utilize the computer services of the University of Missouri at Rolla, Missouri. Computer costs were initially included as a part of the costs of the Erosion and Sediment Work Group. Later computer analyses were incorporated into the Bank Erosion and Flood Plain Scour contract.

The computer at Rolla, Missouri, was used to analyze long-term sediment and discharge data for gages at Hannibal, Missouri, on the Mississippi River and Hermann, Missouri, on the Missouri River. Water discharge (Q) and suspended sediment discharge (Qs) relations were determined for mean monthly, mean annual, and hydrograph position. Percent chance occurrences of selected sediment events on a monthly and annual basis were made for each station. The relations of Qs and Q between stations were analyzed by auto-correlation and cross-correlation techniques. Daily water discharge and suspended sediment concentration curves were also computer plotted.

Stochastic Modeling of Sediment Transport

A statistical analysis was undertaken by the University of Missouri at Rolla to determine a more realistic estimate of the expected sediment transport in the Missouri River at Hermann, Missouri, and the Mississippi River at Hannibal, Missouri. It was decided that in order to make sediment transport rate estimates more rigorous, a statistical indication of the expected variation about the average monthly and average annual transport rates should be computed. From the analysis of the sediment concentration data and discharge data at Hermann and Hannibal it was decided to develop an empirical equation to predict sediment concentration from discharge on a monthly and annual basis. A stochastic model was developed at Hermann and Hannibal to allow improved prediction about the initial predicting equations (39).

It should be noted that past studies have attempted to relate sediment transport rate with discharge for which a very high correlation coefficient was determined. This should be expected since the sediment transport rate is computed from the discharge and it does not correctly indicate the inter-

relationship between the sediment concentration and discharge and introduces a bias into the interrelationship, which in fact is misleading.

IV. SOIL LOSS-SEDIMENT YIELD COMPUTATIONS

Soil Loss Computations

County reliable sheet and rill erosion data was available for Lincoln, Ralls, Randolph, and St. Charles Counties in Missouri. Stratified random point samples were statistically selected in these counties (40). The Universal Soil Loss Equation (37) was used to calculate average annual sheet and rill soil loss for cropland, pastureland, and forest land. Table 7 is a computer printout of average annual sheet and rill soil loss in St. Charles County, Missouri.

The soil loss equation is $A = RKLSCP$ (20)

Where

A is the computed soil loss per unit area, expressed in the units selected for K and for the period selected for R. In practice, these are usually selected so that they compute A in tons per acre per year, but other units can be selected.

R, the rainfall and runoff factor, is the number of rainfall erosion index units (EI) plus a factor for runoff from snowmelt or applied water where such runoff is significant.

K, the soil erodibility factor, is the soil loss rate per erosion index unit for a specified soil as measured on a unit plot, which is defined as a 72.6 ft. length of uniform 9 percent slope continuously in clean-tilled fallow.

L, the slope-length factor, is the ratio of soil loss from the field-slope length to that from a 72.6 ft. length under identical conditions.

S, the slope-steepness factor, is the ratio of soil loss from the field slope gradient to that from a 9 percent slope under otherwise identical conditions.

C, the cover and management factor, is the ratio of soil loss from an area with specified cover and management to that from an identical area in tilled continuous fallow.

P, the support practice factor, is the ratio of soil loss with a support practice like contouring, stripcropping, or terracing to that with straight-row farming up and down the slope.

Average annual soil loss estimates calculated from county reliable stratified random data and detailed average annual soil loss studies on Bay Creek, Illinois, Little Wyaconda-Sugar Creek Watershed, Missouri, and the Cahokia Canal Upland Drainage Area in Illinois were used to estimate average annual

sheet and rill soil losses by USGS land use classifications. Table 8 allows a comparison of detailed average annual soil loss estimates. Average annual soil loss estimates were multiplied by USGS 1980 land use data (Table 9) to determine average annual sheet and rill erosion soil loss estimates for each hydrologic unit. Gully and streambank erosion estimates were based on detailed PL-566 studies in Missouri and Missouri "208" estimates of gully and streambank erosion (26).

Erosion sources were summed to arrive at estimates of gross average annual erosion for each hydrologic unit.

AD-A122 630 GREAT III EROSION AND SEDIMENT INVENTORY (SAVERTON MISSOURI TO CAIRO ILLINOIS)(U) SOIL CONSERVATION SERVICE COLUMBIA MO JUN 82 DACW43-81-C-0071 2/2

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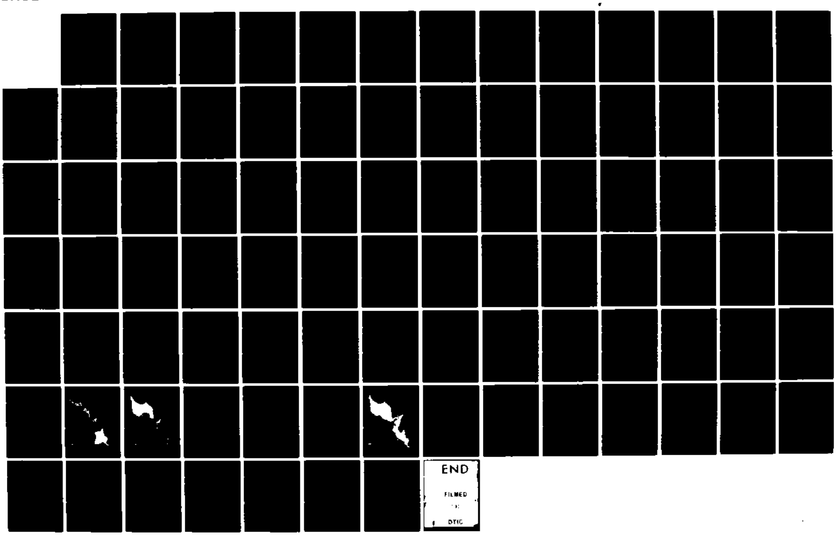

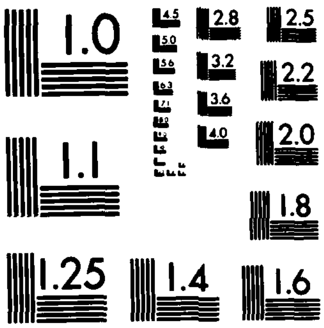
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1.6

TABLE 7 -- Estimated Average Annual Sheet and Rill Erosion by Land Capability Class and Subclass, 1979, St. Charles County, Missouri (40)

Class and subclass	Cultivated		Hay		Other cropland		Total	
	tons	tons/acre	tons	tons/acre	tons	tons/acre	tons	tons/acre
I	97,584	2.99	389	0.40	0	0.00	97,973	2.91
IIe	122,098	8.64	0	0.00	321	0.33	122,419	8.10
IIw	150,915	3.92	0	0.00	0	0.00	150,915	3.92
IIs	15,999	2.53	0	0.00	0	0.00	15,999	2.53
IIc	0	0.00	0	0.00	0	0.00	0	0.00
All II	289,012	4.90	0	0.00	321	0.33	289,333	4.83
IIIe	526,393	15.43	2,362	2.43	33,800	23.12	562,555	15.39
IIIw	132,342	4.11	10	0.02	942	1.93	133,294	4.02
IIIs	2,679	1.83	0	0.00	0	0.00	2,679	1.83
IIIc	0	0.00	0	0.00	0	0.00	0	0.00
All III	661,414	9.77	2,372	1.62	34,742	17.82	698,528	9.82
I-III	1,048,010	6.58	2,761	1.13	35,063	11.99	1,085,834	6.59
IVe	17,006	11.62	0	0.00	0	0.00	17,006	11.62
IVw	0	0.00	0	0.00	0	0.00	0	0.00
IVs	0	0.00	0	0.00	0	0.00	0	0.00
IVc	0	0.00	0	0.00	0	0.00	0	0.00
All IV	17,006	11.62	0	0.00	0	0.00	17,006	11.62
I-IV	1,065,016	6.62	2,761	1.13	35,063	11.99	1,102,840	6.64
V	0	0.00	0	0.00	0	0.00	0	0.00
VIe	8,815	18.10	0	0.00	0	0.00	8,815	18.10
VIw	0	0.00	0	0.00	0	0.00	0	0.00
VIs	0	0.00	0	0.00	0	0.00	0	0.00
VIc	0	0.00	0	0.00	0	0.00	0	0.00
All VI	8,815	18.10	0	0.00	0	0.00	8,815	18.10
VIIe	0	0.00	0	0.00	0	0.00	0	0.00
VIIw	0	0.00	0	0.00	0	0.00	0	0.00
VIIs	0	0.00	0	0.00	784	1.61	784	1.61
VIIc	0	0.00	0	0.00	0	0.00	0	0.00
All VII	0	0.00	0	0.00	784	1.61	784	1.61
VIII	0	0.00	0	0.00	0	0.00	0	0.00
V-VIII	8,815	18.10	0	0.00	784	1.61	9,599	9.66
Total	1,073,831	6.66	2,761	1.13	35,847	10.51	1,112,439	6.66

TABLE 7 -- Continued

Class and subclass	Pastureland		Rangeland		Forest land					
					Grazed		Not grazed		Total	
	tons	tons/acre	tons	tons/acre	tons	tons/acre	tons	tons/acre	tons	tons/acre
I	69	0.14	0	0.00	0	0.00	141	0.04	141	0.04
IIe	5,393	1.38	0	0.00	0	0.00	576	0.59	576	0.59
IIw	2,267	0.78	0	0.00	14	0.03	166	0.04	180	0.04
IIs	1,373	2.82	0	0.00	0	0.00	5	0.01	5	0.01
IIc	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
All II	9,033	1.24	0	0.00	14	0.03	747	0.14	761	0.13
IIIe	93,333	4.79	0	0.00	6,507	2.67	6,900	0.62	13,407	0.98
IIIw	1,772	0.91	0	0.00	107	0.22	356	0.05	463	0.06
IIIs	74	0.08	0	0.00	0	0.00	49	0.01	49	0.01
IIIc	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
All III	95,179	4.25	0	0.00	6,614	2.26	7,305	0.33	13,919	0.56
I-III	104,281	3.45	0	0.00	6,628	1.94	8,193	0.27	14,821	0.43
IVe	48,366	8.27	0	0.00	1,632	1.12	4,250	0.51	5,882	0.60
IVw	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
IVs	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
IVc	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
All IV	48,366	8.27	0	0.00	1,632	1.12	4,250	0.51	5,882	0.60
I-IV	152,647	4.23	0	0.00	8,260	1.70	12,443	0.32	20,703	0.47
V	0	0.00	0	0.00	0	0.00	200	0.06	200	0.06
VIe	33,111	22.65	0	0.00	1,218	2.50	7,701	1.56	8,919	1.66
VIw	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
VIs	745	1.53	0	0.00	1,722	3.53	565	0.56	2,287	1.56
VIc	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
All VI	33,856	17.37	0	0.00	2,940	3.02	8,266	1.41	11,206	1.64
VIIe	0	0.00	0	0.00	0	0.00	945	0.97	945	0.97
VIIw	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
VIIs	38,394	39.38	0	0.00	11,647	5.98	40,306	1.40	51,953	1.69
VIIc	0	0.00	0	0.00	0	0.00	590	1.21	590	1.21
All VII	38,394	39.38	0	0.00	11,647	5.98	41,841	1.38	53,488	1.66
VIII	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
V-VIII	72,250	24.71	0	0.00	14,587	4.99	50,307	1.27	64,894	1.53
Total	224,897	5.77	0	0.00	22,847	2.93	62,750	0.80	85,597	0.99

TABLE 8-- Soil Loss Estimate Resource Comparison

AVERAGE ANNUAL SOIL LOSS ESTIMATES

	INFORMATION SOURCES						
	Lincoln County	Ralls County	Randolph County	St. Charles County	Bay Creek	Little Wyaconda Sugar Watershed	Cahokia Canal Upland Drainage Area
URBAN OR BUILT-UP LAND					2.8T/A		0.5T/A
AGRICULTURAL LAND							
CROP	11.6T/A	8.7T/A	12.2T/A	6.7T/A	15.2T/A	11.6T/A	22.2T/A
PASTURE	1.1T/A	7.0T/A	4.6T/A	5.8T/A	Grass 4.9T/A	6.7T/A	Grass 7.6T/A
FOREST LAND	0.5T/A	2.9T/A	5.2T/A	1.0T/A	0.6T/A	4.5T/A	0.9T/A
BARREN LAND	1.3T/A	1.7T/A	40.6T/A		Feed-lots 62.3T/A		56.3T/A
STREAMBANKS						0.2T/A *(WS)	0.1T/A (WS)
GULLIES						0.6T/A *(WS)	0.1T/A (WS)
EXCEEDING T**	66% crop	42% crop	71% crop				
***LAND CAPABILITY SUBCLASSES							
2E	32% (12.1T/A)	26% (11.9T/A)	26% (11.8T/A)				
3E	26% (18.1T/A)	14% (14.4T/A)	36% (16.4T/A)				
4E	8% (28.7T/A)	1% (7.2T/A)	7% (34.2T/A)				
6E			2% (12.1T/A)				
7E		1% (8.4T/A)					

* Rate to be applied to entire watershed area.

** T = Soil-loss tolerance -- The maximum average annual rate of soil erosion that will permit a high level of crop productivity to be sustained economically and indefinitely.

*** Groups of capability units within classes of the land capability classification that have the same kinds of dominant limitations for agricultural use as a result of soil and climate.

TABLE 9 - Land Use By Hydrologic Cataloging Units In the GREAT III E&S Work Group Study Area

Level 1 * LAND USE	HYDROLOGIC CATALOGING UNITS											
	07110004	07110005	07110006	07110007	07110008	07110009	07140101	07140102	07140103	07140104	07140105	07140107
	ACRES											
Urban or Built-up Land	14,519	4,559	9,301	2,757	8,669	31,654	177,556	48,095	7,700	9,835	16,776	6,466
Agricultural Land **	976,880	501,456	681,348	396,021	637,363	284,378	505,389	330,657	233,693	184,290	712,208	390,516
Rangeland	366	0	722	79	465	0	50	237	336	69	267	237
Forest Land	229,683	59,474	80,220	105,761	147,620	68,231	328,027	983,043	290,397	410,491	281,545	379,246
Water	21,094	445	1,226	504	1,967	12,389	20,314	5,981	1,107	2,916	17,585	880
Wetland	7,346	0	0	0	2,709	7,690	6,698	0	0	0	5,171	1,700
Barren Land ***	1,853	178	830	455	742	1,309	7,975	7,681	929	15,656	4,221	573
TOTAL	1,251,741	566,112	773,647	505,577	799,535	405,651	1,046,009	1,375,694	534,162	623,257	1,037,[illegible]73	779,618

*Source: USGS Land Use and Land Cover Map Series, 1972-1976.

**Agricultural land is defined as cropland, pasture, orchards, groves, vineyards, nurseries, ornamental horticultural areas, confined feeding operations, and other agricultural land.

***Closely approximates SCS, CNI definition of other land.

Sediment Yield Computations

Suspended-sediment discharge estimates were made by: (1) the USGS in Rolla, Missouri, for the Salt River at Monroe City, Missouri, Meramec River near Eureka, Missouri, Mississippi River at Chester, Illinois, and the Mississippi River at Thebes, Illinois; (2) the USGS in Champaign, Illinois, for Bay Creek at Nebo, Illinois. The ARS in Columbia, Missouri, made an estimate of sediment yield for the Goodwater Creek Watershed near Centralia, Missouri.

The suspended sediment discharge estimates for the Mississippi River at Chester and Thebes, Illinois, and the Meramec River near Eureka, Missouri, were used in defining an estimated sediment budget, Figure 32. Total sediment discharge is not yet measurable. Best estimates are that recorded suspended-sediment discharge in rivers, such as the lower Missouri and Mississippi, probably does not differ from the total sediment discharge by more than 10 percent (43). The accuracy of recorded suspended sediment discharge is probably no better than 20 percent. Due to the potential errors, all sediment yield computations and the estimated sediment yields displayed in Figure 29 are intended as best estimates of total sediment.

The suspended sediment discharge estimates for the Salt River at Monroe City, Missouri, Bay Creek at Nebo, Illinois, and the sediment yield estimate for Goodwater Creek near Centralia, Missouri, were considered in modifying Roehl's (35) delivery ratio curve, Figure 33.

Hydrologic Cataloging Unit Computations

In the computations of sediment yield by hydrologic cataloging units that follow, gage data was only used directly in computing sediment yield from hydrologic cataloging units 07110004, 07140102, 07140103, and 07140104. Data collected for Bay Creek Watershed was used in determining the gross delivery ratio for hydrologic cataloging unit 07110004.

Estimates of annual suspended-sediment discharge for the Meramec River near Eureka, Missouri, calculated by the USGS at Rolla, Missouri, for the years 1966-1980 were averaged to give an average annual suspended-sediment discharge of 713,000 tons. The calculated sediment yield of 188.2 tons/sq. mi. was adjusted using the delivery ratio curve, Figure 30, and used to calculate gross sediment yield for hydrologic cataloging units 07140102, 07140103, and 07140104.

The gross sediment yield computations for the remaining hydrologic cataloging units were made by applying the delivery ratio by the specific drainage area in Figure 33.

SOIL LOSS - SEDIMENT YIELD
COMPUTATIONS FOR
HYDROLOGIC CATALOGING UNIT
07110004

Soil loss data developed in a 1979 report for Bay Creek Watershed was the primary source for soil loss rates. USGS gage suspended sediment discharge data was used to determine sediment yield from this watershed. The ratio of sediment yield to soil loss (called delivery ratio) and pertinent soil loss and sediment yield rates from this watershed area were used to calculate soil loss - sediment yield for hydrological cataloging unit 07110004.

AGRICULTURAL LAND SOIL LOSS

Rates of erosion for cropland - 15.21 T/A/Y, grassland - 4.95 T/A/Y, and feedlots - 62.28 T/A/Y determined in the Bay Creek study, were used to calculate soil loss from agricultural land.

Cropland - Pasture mix is the primary component of the agricultural land class. The percent cropland and pasture in this mix was derived from the 1978 update of CNI data for Missouri's "208" study (26).

CNI BASINS - 07110004 IN MISSOURI

	*CROPLAND (%)	*PERM. PAST. (%)	TOTAL D.A. (ACRES)
050010	53.76	16.74	860,071
050020	59.71	25.00	482,866
052300	48.84	30.91	47,137
	Wt. av. = 55.6%	20.1%	1,390,074

* This data in 1978 was developed as a 1974 update of CNI data. Census and SRS 1974 land use data were used by county committees in estimating 1974 land use.

In Bay Creek, cropland comprised 49.3 percent and grassland 27.5 percent of the drainage area. Thus, the weighted averages of 55.6 percent and 20.1 percent appear realistic for hydrologic cataloging unit 07110004. This gives a cropland - pasture mix of 73 percent and 27 percent, respectively.

SOIL LOSS RATE CALCULATIONS

Agricultural Land: Cropland 15.21 T/A/Y X .73 - 11.10

Pasture 4.95 T/A/Y X .27 - 1.34

Cropland-Pasture wt. av. = 12.44 T/A/Y

Landsat agricultural land in 07110004 = 976,880 acres.
99.7 percent was mapped cropland and pasture. The remaining 0.3 percent was mapped as orchards, groves, vineyards, nurseries, ornamental horticultural areas, confined feeding operations, and other agricultural lands.

0.997 X 12.44 T/ac. = 12.40 T/A/Y
0.003 X 62.28 T/ac. = 0.19 T/A/Y
Ag. Land wt. av. = 12.59 T/A/Y

Rangeland: The rate of soil loss was estimated to be 2.0 tons per acre per year.

Forest land: The rate of 0.55 tons per acre per year developed in the Bay Creek study was used.

Barren land: This land use class is best approximated in 07110004 by CNI other land (26).

CNI BASINS	SOIL LOSS RATES	DECIMAL BARREN	TOTAL D. A.	ACRES BARREN
050010	9.63 T/A/Y	.0622	860,071	53,496
050020	4.11 T/A/Y	.0230	482,866	11,106
052300	5.04 T/A/Y	.0236	47,137	1,112
	Wt. Av. = 8.6 T/A/Y		1,390,074	65,714

Urban or Built-Up Land: The rate of 2.75 T/A/Y used in the Bay Creek study for urban and commercial land was used.

Gully Erosion:

A rate of 400 tons per square mile per year was used and applied to the entire drainage area. This rate was based on a rate of 600 tons per acre per year developed in detailed field study in 1979 by SCS on the Little Wyaconda-Sugar Creek Watershed and toned down for the contribution of bottom land to the total drainage area of 07110004.

Streambank Erosion:

A rate of 100 tons per square mile per year was used based on detailed field work on Little Wyaconda-Sugar Creek Watershed toned down for the larger percentage of low gradient streams in 07110004.

TABLE 10 -- 07110004 Estimated Soil Loss - Sediment Yield

EROSION SOURCES	MULTIPLIER	SOIL LOSS RATE (T/A/Y)	SOIL LOSS** (TONS/Y)	DELIVERY* RATIO		SEDIMENT YIELD (TONS/Y)	
				Initial	Adjusted	Initial	Adjusted
Urban or Built-Up Land	14,519	2.8	41,000	.5	.3	20,500	14,880
Agricultural Land	976,880	12.6	12,309,000	.4	.3	4,923,600	3,429,870
Rangeland	366	2.0	1,000	.3	.2	300	210
Forest Land	229,683	0.6	138,000	.3	.2	41,400	28,840
Barren Land	1,853	8.6	16,000	.3	.2	4,800	3,340
Streambanks	1,223,301	0.2	245,000	.9	.6	220,500	147,000
Gullies	1,223,301	0.6	734,000	.8	.6	587,200	440,400
		TOTAL	13,484,000	.30		4,064,540	

* Based on detailed soil loss computations for the Bay Creek Watershed area and 41 years of suspended sediment discharge data, a delivery ratio of 30 percent appears reasonable for the Bay Creek drainage. This 30 percent delivery ratio was used to calculate sediment yield from hydrologic cataloging unit 07110004. This delivery ratio is consistent with studies done by Finney in northwest Missouri (27). Delivery ratios applicable to erosion sources were adjusted to fit the gross soil loss - sediment yield relationship.

** Rounded to nearest thousand.

SOIL LOSS - SEDIMENT YIELD COMPUTATIONS FOR HYDROLOGIC CATALOGING UNIT 07110005

Soil Conservation Service county reliable NRI soil loss estimates for Randolph and Ralls Counties were used to compute soil loss from agricultural land, forest land, and barren land.

AGRICULTURAL LAND SOIL LOSS

Cropland - Pasture comprises 99.9 percent of the agricultural land class. Sources of the percent cropland pasture applied to weighted average soil loss rates are shown below.

	CROPLAND	PASTURE	TOTAL D.A. (Acres)
Ralls County (NRI)	59%	15%	305,920
Randolph County (NRI)	45%	25%	302,080
050010 (CNI BASIN)*	53.7%	16.74%	860,071
wt. av. =	53%	18%	1,468,071

The cropland - pasture mix is estimated to be 75 percent crop and 25 percent pasture.

*This data was developed in 1978 as a 1974 update of CNI data. Census and 1974 SRS land use data were used by county committees in estimating 1974 land use.

SOIL LOSS RATE CALCULATIONS

Agricultural Land:

Cropland	12.2 T/A/Y	X	302,080	= 3,685,376
	8.7 T/A/Y	X	305,920	= 2,661,504
wt. av.	= 10.4 T/A/Y		608,000	6,346,880
Pasture	4.6 T/A/Y	X	302,080	= 1,389,568
	7.0 T/A/Y	X	305,920	= 2,141,440
wt. av.	= 5.8 T/A/Y		608,000	3,531,080

Cropland - Pasture wt. av. = 10.4 T/A/Y X .75 + 5.8 T/A/Y X .25 = 9.2 T/A/Y

Forest land-the wt. av. $= \frac{2.9 \text{ T/A/Y} \times 305{,}920 + 5.2 \text{ T/A/Y} \times 302{,}080}{608{,}000} = 4.0 \text{ T/A/Y}$

Barren land-the wt. av. $= \frac{1.7 \text{ T/A/Y} \times 305{,}920 + 40.6 \text{ T/A/Y} \times 302{,}080}{608{,}000} = 21.0 \text{ T/A/Y}$

Urban or built-up land - a rate of 2.8 tons per acre per year was used.

Gully Erosion:

A rate of 0.6 T/A/Y was used and applied to the entire drainage area. This rate was based on detailed studies in the Little Wyaconda-Sugar Creek Watershed.

Streambank Erosion:

A rate of 0.2 T/A/Y was used and applied to the entire drainage area. This rate was based on detailed studies in the Little Wyaconda-Sugar Creek Watershed.

TABLE 11 -- 07110005 Estimated Soil Loss - Sediment Yield

EROSION SOURCES	MULTIPLIER	SOIL LOSS RATE (T/A/Y)	SOIL LOSS* (TONS/Y)	DELIVERY RATIO		SEDIMENT YIELD (TONS/Y)	
				Initial**	Adjusted**	Initial	Adjusted
Urban or Built-Up Land	4,559	2.8	13,000	.5	.4	6,500	5,065
Agricultural Land	501,456	9.2	4,613,000	.4	.3	1,845,200	1,437,752
Rangeland	0	0	0	0	0	0	0
Forest Land	59,474	4.0	238,000	.4	.3	95,200	74,178
Barren Land	178	21.0	4,000	.4	.3	1,600	1,247
Streambanks	565,667	0.2	113,000	.9	.7	101,700	79,243
Gullies	565,667	0.6	339,000	.8	.6	271,200	211,315
		TOTAL	5,320,000	.34		1,808,800	

* Rounded to nearest thousand.
**Initial delivery ratios were based on a curve developed for northwest Missouri by Finney (27). Adjusted delivery ratios based on the modified delivery rate curve, Figure 33.

SOIL LOSS - SEDIMENT YIELD COMPUTATIONS FOR HYDROLOGIC CATALOGING UNIT 07110006

Soil Conservation Service county reliable NRI soil loss estimates for Randolph and Ralls Counties were used to compute soil loss from agricultural land, forest land, and barren land.

AGRICULTURAL LAND SOIL LOSS

Cropland - Pasture comprises 99.9 percent of the agricultural land class. Sources of the percent crop and pasture applied to weighted average soil loss rates are shown below.

	CROPLAND	PASTURE	TOTAL D.A. (ACRES)
Ralls County (NRI)	59%	15%	305,920
Randolph County (NRI)	45%	25%	302,080
052500 (CNI BASIN)*	63.08%	21.44%	1,845,668
wt. av. =	60%	21%	2,453,668

The cropland pasture mix is estimated to be 74 percent crop and 26 percent pasture.

*This data was developed in 1978 as a 1974 update of CNI data. Census and 1974 SRS land use data were used by county committees in estimating 1974 land use.

SOIL LOSS RATE CALCULATIONS

Agricultural Land - Cropland	12.2 T/A/Y	X	302,080	=	3,685,376
	8.7 T/A/Y	X	305,920	=	2,661,504
wt. av. =	10.4 T/A/Y		608,000		6,346,880
Pasture	4.6 T/A/Y	X	302,080	=	1,389,568
	7.0 T/A/Y	X	305,920	=	2,141,440
wt. av. =	5.8 T/A/Y		608,000		3,531,080

Cropland - Pasture wt. av. = 10.4 T/A/Y X .74 + 5.8 T/A/Y X .26 = 9.2 T/A/Y

Forest land - wt. av. = $\frac{2.9 \text{ T/A/Y X } 305{,}920 + 5.2 \text{ T/A/Y X } 302{,}080}{608{,}000}$ = 4.0 T/A/Y

Rangeland - rate of soil loss was estimated to be 2.0 T/A/Y.

Barren land - wt. av. = $\frac{1.7 \text{ T/A/Y} \times 305{,}920 + 40.6 \text{ T/A/Y} \times 302{,}080}{608{,}000}$ = 21.0 T/A/Y

Urban or built-up land - rate of soil loss was estimated to be 2.8 T/A/Y.

Gully Erosion:

Rate of 0.6 T/A/Y was used and applied to the entire drainage area. This rate was based on detailed studies in Little Wyaconda-Sugar Creek Watershed.

Streambank Erosion:

Rate of 0.2 T/A/Y was used and applied to the entire drainage area. This rate was based on detailed studies in Little Wyaconda-Sugar Creek Watershed.

TABLE 12 -- 07110006 Estimated Soil Loss* - Sediment Yield

EROSION SOURCES	MULTIPLIER	SOIL LOSS RATE (T/A/Y)	SOIL LOSS* (TONS/Y)	DELIVERY RATIO		SEDIMENT YIELD (TONS/Y)	
				Initial**	Adjusted**	Initial	Adjusted
Urban or Built-Up Land	9,301	2.8	26,000	.5	.4	13,000	9,530
Agricultural Land	681,348	9.2	6,268,000	.4	.3	2,507,200	1,837,938
Rangeland	722	2.0	1,000	.4	.3	400	293
Forest Land	80,220	4.0	321,000	.4	.3	128,400	94,125
Barren Land	830	21.0	17,000	.4	.3	6,800	4,985
Streambanks	772,421	0.2	154,000	.9	.7	138,600	101,602
Gullies	772,421	0.6	463,000	.8	.6	370,400	271,527
		TOTAL	7,250,000	.32		2,320,000	

* Rounded to nearest thousand.

** Initial delivery ratios were based on a curve developed for northwest Missouri by Finney (27). Adjusted delivery ratios based on the modified delivery ratio curve, Figure 33.

SOIL LOSS - SEDIMENT YIELD
COMPUTATIONS FOR
HYDROLOGIC CATALOGING UNIT
07110007

Soil Conservation Service county reliable NRI soil loss estimates for Ralls County were used to compute soil loss from agricultural land, forest land, and barren land.

AGRICULTURAL LAND SOIL LOSS

Cropland - Pasture comprises 99.9 percent of the agricultural land class. Sources of the percent crop and pasture applied to weighted average soil loss rates are shown below.

	CROPLAND	PASTURE	TOTAL D.A. (ACRES)
Ralls County (NRI)	59%	15%	305,922
052500 (CNI BASIN)*	63.08%	21.44%	1,845,668
wt. av. =	62%	21%	2,151,590

The cropland pasture mix is estimated to be 75 percent crop and 25 percent pasture.

*This data was developed in 1978 as a 1974 update of CNI data. Census and 1974 SRS land use were used by county committees in estimating 1974 land use.

SOIL LOSS RATE CALCULATIONS

Agricultural Land:

Cropland - Pasture wt. av. = 8.7 T/A/Y X .75 + 7.0 T/A/Y X .25 = 8.3 T/A/Y

Forest Land: Used 2.9 T/A/Y

Rangeland: Used 2.0 T/A/Y

Barren Land: Used 21.0 T/A/Y

Urban or Built-Up Land: Used 2.8 T/A/Y

Gully Erosion:

Rate of 0.4 T/A/Y was used and applied to the entire drainage area. This rate was adjusted downward from detailed studies done in Little Wyaconda-Sugar Creek Watershed.

Streambank Erosion:

Rate of 0.1 T/A/Y was used and applied to the entire drainage area. This rate was adjusted downward from rates determined in detailed studies of Little Wyaconda-Sugar Creek Watershed.

TABLE 13 -- 0711007 Estimated Soil Loss - Sediment Yield

EROSION SOURCES	MULTIPLIER	SOIL LOSS RATE (T/A/Y)	SOIL LOSS* (TONS/Y)	DELIVERY RATIO		SEDIMENT YIELD (TONS/Y)	
				Initial**	Adjusted**	Initial	Adjusted
Urban or Built-Up Land	2,757	2.8	8,000	.4	.4	3,200	3,255
Agricultural Land	396,021	8.3	3,287,000	.3	.3	986,100	1,003,050
Rangeland	79	2.0	200	.3	.3	60	61
Forest Land	105,761	2.9	307,000	.3	.3	92,100	93,683
Barren Land	455	21.0	10,000	.3	.3	3,000	3,052
Streambanks	505,073	0.1	51,000	.9	.9	45,900	46,689
Gullies	505,073	0.4	202,000	.8	.8	161,600	164,378
		TOTAL	3,865,200	.34			1,314,168

* Rounded to nearest thousand.

** Inital delivery ratios were based on a curve developed for northwest Missouri by Finney (27). Adjusted delivery ratios based on the modified delivery ratio curve, Figure 33.

SOIL LOSS - SEDIMENT YIELD
COMPUTATIONS FOR
HYDROLOGIC CATALOGING UNIT
07110008

Soil Conservation Service county reliable NRI soil loss estimates for Lincoln and Ralls Counties were used to compute soil loss from agricultural land, forest land, and barren land.

AGRICULTURAL LAND SOIL LOSS

Cropland - Pasture comprises 99.7 percent of the agricultural land class. Sources of the percent crop and pasture applied to weighted average soil loss rates are shown below.

	CROPLAND	PASTURE	TOTAL D.A. (ACRES)
Lincoln County (NRI)	42%	20%	400,000
Ralls County (NRI)	59%	15%	305,920
052600 (CNI BASIN)*	57.25%	15.07%	870,043
wt. av. =	53.7%	16.3%	1,575,963

The cropland-pasture mix is estimated to be 77 percent crop and 23 percent pasture.

*This data in 1978 was developed as a 1974 update of CNI data. Census and SRS 1974 land use data were used by county committees in estimating 1974 land use.

SOIL LOSS RATE CALCULATIONS

Agricultural Land:	Cropland	11.6 T/A/Y X	400,000 =	4,640,000
		8.7 T/A/Y X	305,920 =	2,661,504
	wt. av. =	10.3 T/A/Y	705,920	2,581,440
	Pasture	1.1 T/A/Y X	400,000 =	440,000
		7.0 T/A/Y X	305,920 =	2,141,440
	wt. av. =	3.7 T/A/Y	705,920	2,581,440

Cropland-Pasture wt. av. = 10.3 T/A/Y X .77 + 3.7 T/A/Y X .23 = 8.8 T/A/Y.

Rangeland: the rate of soil loss was estimated to be 2.0 tons per acre per year.

Forest Land: the wt. av. $= \dfrac{0.5 \text{ T/A/Y} \times 400{,}000 \text{ A} + 2.9 \text{ T/A/Y} \times 305{,}920}{705{,}920 \text{ A}} = 1.5 \text{ T/A/Y}$

Barren Land: the wt. av. $= \frac{1.3 \text{ T/A/Y X } 400{,}000 \text{ A} + 1.7 \text{ T/A/Y X } 305{,}920}{705{,}920 \text{ A}} = \underline{1.5 \text{ T/A/}}$

Urban or Built-Up Land: a rate of 2.8 tons per acre per year was used.

Gully Erosion:

A rate of 200 tons per square mile per year was used and applied to the entire drainage area.

Sreambank Erosion:

A rate of 50 tons per square mile per year was used and applied to the entire drainage area.

TABLE 14 -- 07110008 Estimated Soil Loss - Sediment Yield

EROSION SOURCES	MULTIPLIER	SOIL LOSS RATE (T/A/Y)	SOIL LOSS* (TONS/Y)	DELIVERY RATIO		SEDIMENT YIELD (TONS/Y)	
				Initial**	Adjusted**	Initial	Adjusted
Urban or Built-Up Land	8,669	2.8	24,000	.4	.4	9,600	9,311
Agricultural Land	637,363	8.8	5,609,000	.3	.3	1,682,700	1,632,101
Rangeland	465	2.0	1,000	.3	.3	300	291
Forest Land	147,620	1.5	221,000	.3	.3	66,300	64,306
Barren Land	742	1.5	1,000	.3	.3	300	291
Streambanks	794,859	0.3	238,000	.9	.9	214,200	207,760
Gullies	794,859	0.1	79,000	.8	.8	63,200	61,300
	TOTAL		6,173,000	.32		1,975,360	

* Rounded to nearest thousand.

**Initial delivery ratios were based on a curve developed for northwest Missouri by Finney (27). Adjusted delivery ratios based on the modified delivery ratio curve, Figure 33.

SOIL LOSS - SEDIMENT YIELD
COMPUTATIONS FOR
HYDROLOGIC CATALOGING UNIT
07110009

Soil Conservation Service county reliable NRI soil loss estimates for St. Charles County were used to compute soil loss from agricultural land, forest land, and barren land.

AGRICULTURAL LAND SOIL LOSS

Cropland-Pasture comprises 99.7 percent of the agricultural land class. The percent crop and pasture from the St. Charles County reliable NRI data was 48.6 percent and 11.3 percent, respectively. This gives a crop-pasture mix estimate of 81 percent crop and 19 percent pasture.

SOIL LOSS RATE CALCULATIONS

Agricultural Land:	Cropland	6.7 T/A/Y X .81 =	5.4
	Pasture	5.8 T/A/Y X .19 =	1.1
	wt. av. =		6.5 T/A/Y

Forest Land: the SCS NRI calculation of 1.0 T/A/Y for St. Charles County was used.

Barren Land: a rate of 1.5 T/A/Y was used

Urban or Built-Up Land: a rate of 2.8 T/A/Y was used

Gully Erosion:

A rate of 200 tons per square mile per year was used and applied to the entire drainage area.

Streambank Erosion:

A rate of 50 tons per square mile per year was used and applied to the entire drainage area.

SOIL LOSS - SEDIMENT YIELD
COMPUTATIONS FOR
HYDROLOGIC CATALOGING UNIT
07140101

A SCS "Erosion and Sediment Study of Cahokia Canal Upland Drainage Area" and the SCS April 1978 "Erosion Inventory" were used to estimate soil loss rates.

AGRICULTURAL LAND SOIL LOSS

Cropland - Pasture comprises 99.8 percent of the agricultural land class. Sources of percent crop and pasture applied to weighted average soil loss rates are shown below.

	CROPLAND	(GRASSLAND) PASTURE	TOTAL D.A. (ACRES)
Cahokia Canal Upland D.A. (Ill. SCS)	35.4%	15.1%	30,980
050000 (CNI BASIN)*	30.64%	13.67%	1,900,714
wt. av. =	31%	14%	1,931,694

The cropland-pasture mix is estimated to be 69 percent crop and 31 percent pasture.

*This data in 1978 was developed as a 1974 update of CNI data. Census and SRS 1974 land use data were used by county committees in estimating 1974 land use.

SOIL LOSS RATE CALCULATIONS

Agricultural Land: Cropland Est. $= \frac{22.2 \text{ T/A/Y} + 13.6 \text{ T/A/Y}}{2} = 17.9 \text{ T/A/Y}$

Pasture Est. $= \frac{7.6 \text{ T/A/Y} + 4.2 \text{ T/A/Y}}{2} = 5.9 \text{ T/A/Y}$

Est. Ag. Land = 17.9 T/A/Y X 6.9 + 5.9 T/A/Y X .31 = $\underline{14.2 \text{ T/A/Y}}$

Rangeland: a rate of 2.0 T/A/Y was used

Forest Land Est.: $\frac{1.8 \text{ T/A/Y} + 3.7 \text{ T/A/Y}}{2} = \underline{2.8 \text{ T/A/Y}}$

Barren Land Est.: $\frac{2.1 \text{ T/A/Y} + 12.4 \text{ T/A/Y}}{2} = \underline{7.2 \text{ T/A/Y}}$

Urban or Built Up Land Est.: 1.3 T/A/Y

Gully Erosion Est.: 0.1 T/A/Y

Streambank Erosion Est.: 0.1 T/A/Y

TABLE 15 -- 07110009 Estimated Soil Loss - Sediment Yield

EROSION SOURCES	MULTIPLIER	SOIL LOSS RATE (T/A/Y)	SOIL LOSS* (TONS/Y)	DELIVERY RATIO		SEDIMENT YIELD (TONS/Y)	
				Initial**	Adjusted**	Initial	Adjusted
Urban or Built-Up Land	31,654	2.8	89,000	.5	.4	44,500	35,546
Agricultural Land	284,378	6.5	1,848,000	.4	.3	739,200	590,471
Rangeland	0	0	0	0	0	0	0
Forest Land	68,231	1.0	68,000	.4	.3	27,200	21,727
Barren Land	1,309	1.5	2,000	.4	.3	800	640
Streambanks	385,572	0.3	116,000	.9	.7	104,400	83,394
Gullies	385,572	0.1	39,000	.8	.6	31,200	24,922
	TOTAL		2,162,000	.35		756,700	

* Rounded to nearest thousand.

** Initial delivery ratios were based on a curve developed for northwest Missouri by Finney (27). Adjusted delivery ratios based on the modified delivery ratio curve, Figure 33.

TABLE 16 -- 07140101 Estimated Soil Loss - Sediment Yield

EROSION SOURCES	MULTIPLIER	SOIL LOSS RATE (T/A/Y)	SOIL LOSS* (TONS/Y)	DELIVERY RATIO		SEDIMENT YIELD (TONS/Y)	
				Initial**	Adjusted**	Initial	Adjusted
Urban or Built-Up Land	177,556	1.3	231,000	.4	.4	92,400	84,863
Agricultural Land	505,389	14.2	7,177,000	.3	.3	2,153,100	1,977,472
Rangeland	50	2.0	100	.3	.3	30	28
Forest Land	328,027	2.8	918,000	.3	.3	275,400	252,936
Barren Land	7,975	7.2	57,000	.3	.3	17,100	15,705
Streambanks	1,018,997	0.1	102,000	.9	.8	91,800	84,312
Gullies	1,018,997	0.1	102,000	.8	.7	81,600	74,945
		TOTAL	8,587,100	.29		2,490,259	

* Rounded to nearest thousand.

** Initial delivery ratios were based on a curve developed for northwest Missouri by Finney (27). Adjusted delivery ratios based on the modified delivery ratio curve, Figure 33.

SOIL LOSS - SEDIMENT YIELD COMPUTATIONS FOR HYDROLOGIC CATALOGING UNIT 07140102

The SCS April 1978 "Erosion Inventory" was used to estimate soil loss rates.

AGRICULTURAL LAND SOIL LOSS

Cropland - Pasture comprises 99.7 percent of the agricultural land class. The cropland-pasture mix is estimated to be 36 percent crop and 64 percent pasture.

SOIL LOSS RATE CALCULATIONS

Agricultural Land Est.: 11.9 T/A/Y X .36 + 6.0 T/A/Y X .34 = 6.3 T/A/Y

Rangeland Est.: 2.0 T/A/Y

Forest Land Est.: 0.27 T/A/Y X .6 + 1.96 T/A/Y X .4 = 1.0 T/A/Y

Barren Land Est.: 12.8 T/A/Y

Urban or Built-Up Land Est.: 1.3 T/A/Y

Gully Erosion Est.: 0.1 T/A/Y

Streambank Erosion Est.: 0.1 T/A/Y

TABLE 17 -- 07140102 Estimated Soil Loss - Sediment Yield

EROSION SOURCES	MULTIPLIER	SOIL LOSS RATE (T/A/Y)	SOIL LOSS* (TONS/Y)	DELIVERY RATIO		SEDIMENT YIELD (TONS/Y)	
				Initial**	Adjusted**	Initial	Adjusted
Urban or Built-Up Land	48,095	1.3	63,000	.4	.2	25,200	10,132
Agricultural Land	330,657	6.3	2,083,000	.3	.1	624,900	251,249
Rangeland	237	2.0	500	.3	.1	150	60
Forest Land	983,043	1.0	983,000	.3	.1	294,900	118,560
Barren Land	7,681	12.8	98,000	.3	.1	29,400	11,821
Streambanks	1,369,713	0.1	137,000	.9	.4	123,300	49,574
Gullies	1,369,713	0.1	137,000	.8	.3	109,600	44,066
		TOTAL	3,501,500	.14		485,470***	

* Rounded to nearest thousand.

**Initial delivery ratios were based on a curve developed for northwest Missouri by Finney (27). Adjusted delivery ratios correlate to the gross delivery ratio compatible with gross suspended-sediment discharge to the Eureka, Missouri, gage on the Meramec River.

***Calculated from the 1966-1980 average annual suspended sediment discharge to the Eureka, Missouri, gage on the Meramec River.

Calculation: $\frac{712{,}947 \text{ tons/Y}}{3{,}788 \text{ sq. mi.}} = 188.2$ tons/sq. mi./Y

$$188.2 \text{ tons/sq. mi./Y} \times \frac{.30 \text{ (delivery ratio 2150 sq. mi.)}}{.25 \text{ (delivery ratio 3788 sq. mi.)}} = 225.8 \text{ tons/sq. mi./Y}$$

$$225.8 \text{ tons/sq. mi./Y} \times 2150 \text{ sq. mi.} = 485{,}470 \text{ tons/Y}$$

SOIL LOSS - SEDIMENT YIELD
COMPUTATIONS FOR
HYDROLOGIC CATALOGING UNIT
07140103

The SCS April 1978 "Erosion Inventory" was used to estimate soil loss rates.

AGRICULTURAL LAND SOIL LOSS

Cropland - Pasture comprises 99.9 percent of the agricultural land class. The cropland-pasture mix is estimated to be 63 percent pasture and 37 percent crop.

SOIL LOSS RATE CALCULATIONS

Agricultural Land Est.: 9.78 T/A/Y X .37 + 4.2 T/A/Y X .63 = 6.3 T/A/Y

Rangeland Est.: 2.0 T/A/Y

Forest Land Est.: 0.23 T/A/Y X .76 + 1.6 T/A/Y X .24 = 0.6 T/A/Y

Barren Land Est.: 8.6 T/A/Y

Urban or Built-Up Land: 1.3 T/A/Y

Gully Erosion Est.: 0.1 T/A/Y

Streambank Erosion Est.: 0.1 T/A/Y

TABLE 18 -- 07140103 Estimated Soil Loss - Sediment Yield

EROSION SOURCES	MULTIPLIER	SOIL LOSS RATE (T/A/Y)	SOIL LOSS* (TONS/Y)	DELIVERY RATIO		SEDIMENT YIELD (TONS/Y)	
				Initial**	Adjusted**	Initial	Adjusted
Urban or Built-Up Land	7,700	1.3	10,000	.4	.2	4,000	1,703
Agricultural Land	233,693	6.3	1,472,000	.3	.1	441,600	187,988
Rangeland	336	2.0	1,000	.3	.1	300	128
Forest Land	290,397	0.6	174,000	.3	.1	52,200	22,221
Barren Land	929	8.6	8,000	.3	.3	2,400	1,022
Streambanks	533,055	0.1	53,000	.9	.4	47,700	20,306
Gullies	533,055	0.1	53,000	.8	.3	42,400	18,050
		TOTAL	1,771,000	.14		251,418***	

* Rounded to nearest thousand.

** Initial delivery ratios were based on a curve developed for northwest Missouri by Finney (27). Adjusted delivery ratios correlate to the gross delivery ratio compatible with gross suspended-sediment discharge to the Eureka, Missouri, gage on the Meramec River.

*** Calculated from the 1966-1980 average annual suspended sediment discharge to the Eureka, Missouri gage on the Meramec River.

Calculation:

$$\frac{712{,}947 \text{ tons/Y}}{3{,}798 \text{ sq. mi.}} = 188.2 \text{ Tons/sq. mi./Y}$$

$$188.2 \text{ tons/sq. mi./Y} \times \frac{40}{25}\,\frac{\text{(Delivery ratio 835 sq. mi.)}}{\text{(delivery ratio 3788 sq. mi.)}} = 301.1 \text{ tons/sq. mi./Y}$$

$$301.1 \text{ tons/sq. mi./Y} \times 835 \text{ sq. mi.} = 251{,}418 \text{ tons/Y.}$$

SOIL LOSS - SEDIMENT YIELD
COMPUTATIONS FOR
HYDROLOGIC CATALOGING UNIT
07140104

The SCS April 1978 "Erosion Inventory" was used to estimate soil loss rates.

AGRICULTURAL LAND SOIL LOSS

Cropland - Pasture comprises 99.9 percent of the agricultural land class. The cropland-pasture mix is estimated to be 57 percent pasture and 43 percent crop.

Agricultural Land Est.: 4.32 T/A/Y X .57 + 7.02 T/A/Y X .43 = 5.5 T/A/Y

Rangeland Est.: 2.0 T/A/Y

Forest Land Est.: 0.21 T/A/Y X .53 + 2.32 T/A/Y X .47 = 1.2 T/A/Y

Barren Land Est.: 10.5 T/A/Y

Urban or Built-Up Land: 1.3 T/A/Y

Gully Erosion Est.: 0.1 T/A/Y

Streambank Erosion Est.: 0.1 T/A/Y

TABLE 19 -- 07140104 Estimated Soil Loss - Sediment Yield

EROSION SOURCES	MULTIPLIER	SOIL LOSS RATE (T/A/Y)	SOIL LOSS* (TONS/Y)	DELIVERY RATIO		SEDIMENT YIELD (TONS/Y)	
				Initial**	Adjusted**	Initial	Adjusted
Urban or Built-Up Land	9,835	1.3	13,000	.4	.2	5,200	2,305
Agricultural Land	184,290	5.5	1,014,000	.3	.1	304,200	134,840
Rangeland	69	2.0	200	.3	.1	60	27
Forest Land	410,491	1.2	493,000	.3	.1	147,900	65,559
Barren Land	15,656	10.5	164,000	.3	.1	49,200	21,808
Streambanks	620,341	0.1	62,000	.9	.4	55,800	24,734
Gullies	620,341	0.1	62,000	.8	.4	49,600	21,986
		TOTAL	1,808,200	.15		271,259***	

* Rounded to nearest thousand.

** Initial delivery ratios were based on a curve developed for northwest Missouri by Finney (27). Adjusted delivery ratios correlate to the gross delivery ratio compatible with gross suspended-sediment discharge to the Eureka, Missouri, gage on the Meramec River.

*** Calculated from the 1966-1980 average annual suspended sediment discharge to the Eureka, Missouri, gage on the Merame River.

Calculation: $\frac{712{,}947 \text{ tons/Y}}{3798 \text{ sq. mi.}} = 188.2$ tons/sq. mi./Y

$188.2 \text{ tons/sq. mi./Y} \times \frac{37 \text{ (delivery ratio 947 sq. mi.)}}{25 \text{ (delivery ratio 3788 sq. mi.)}} = 278.5$ tons/sq. mi./Y

278.5 tons/sq. mi./Y X 974 sq. mi. = 271,259 tons/Y

SOIL LOSS - SEDIMENT YIELD
COMPUTATIONS FOR
HYDROLOGIC CATALOGING UNIT
07140105

The SCS April 1978 "Erosion Inventory" was used to estimate soil loss rates.

AGRICULTURAL LAND SOIL LOSS

Cropland - Pasture comprises 99.8 percent of the agricultural land class. The cropland-pasture mix is estimated to be 31 percent pasture and 69 percent crop.

Agricultural Land Est.: 4.24 T/A/Y X .31 + 13.64 T/A/Y X .69 = 10.7 T/A/Y

Rangeland Est.: 2.0 T/A/Y

Forest Land Est.: 0.35 T/A/Y X .7 + 3.72 T/A/Y X .3 = 1.4 T/A/Y

Barren Land Est.: 12.42 T/A/Y

Urban or Built-Up Land: 1.3 T/A/Y

Gully Erosion Est.: 0.2 T/A/Y

Streambank Erosion Est.: 0.2 T/A/Y

TABLE 20 -- 07140105 Estimated Soil Loss - Sediment Yield

EROSION SOURCES	MULTIPLIER	SOIL LOSS RATE (T/A/Y)	SOIL LOSS* (TONS/Y)	DELIVERY RATIO		SEDIMENT YIELD (TONS/Y)	
				Initial**	Adjusted**	Initial	Adjusted
Urban or Built-Up Land	16,776	1.3	22,000	.4	.4	8,800	7,815
Agricultural Land	712,208	10.7	7,621,000	.3	.3	2,286,300	2,030,449
Rangeland	267	2.0	1,000	.3	.3	300	266
Forest Land	281,545	1.4	394,000	.3	.3	118,200	104,973
Barren Land	4,221	12.4	52,000	.3	.3	15,600	13,854
Streambanks	1,015,017	0.2	203,000	.9	.8	182,700	162,255
Gullies	1,015,017	0.2	203,000	.8	.7	152,400	144,228
	TOTAL		8,496,000	.29		2,463,840	

* Rounded to nearest thousand.

** Initial delivery ratios were based on a curve developed for northwest Missouri by Finney (27). Adjusted delivery ratios based on the modified delivery ratio curve, Figure 33.

SOIL LOSS - SEDIMENT YIELD
COMPUTATIONS FOR
HYDROLOGIC CATALOGING UNIT
07140107

The SCS April 1978 "Erosion Inventory" was used to estimate soil loss rates.

AGRICULTURAL LAND SOIL LOSS

Cropland - Pasture comprises 99.9 percent of the agricultural land class. The cropland-pasture mix is estimated to be 31 percent pasture and 69 percent crop.

Agricultural Land Est.: 4.24 T/A/Y X .31 + 13.64 T/A/Y X .69 = 10.7 T/A/Y

Rangeland Est.: 2.0 T/A/Y

Forest Land Est.: 0.35 T/A/Y X .7 + 3.72 T/A/Y X .3 = 1.4 T/A/Y

Barren Land Est.: 12.42 T/A/Y

Urban or Built-Up Land: 1.3 T/A/Y

Gully Erosion Est.: 0.2 T/A/Y

Streambank Erosion Est.: 0.2 T/A/Y

TABLE 21 -- 07140107 Estimated Soil Loss - Sediment Yield

EROSION SOURCES	MULTIPLIER	SOIL LOSS RATE (T/A/Y)	SOIL LOSS* (TONS/Y)	DELIVERY RATIO		SEDIMENT YIELD (TONS/Y)	
				Initial**	Adjusted**	Initial	Adjusted
Urban or Built-Up Land	6,466	1.3	8,000	.4		3,200	3,066
Agricultural Land	390,516	10.7	4,179,000	.3		1,253,700	1,201,083
Rangeland	237	2.0	500	.3		150	144
Forest Land	379,246	1.4	531,000	.3		159,300	152,614
Barren Land	573	12.4	7,000	.3		2,100	2,012
Streambanks	777,038	0.2	155,000	.9		139,500	133,645
Gullies	777,038	0.2	155,000	.8		124,000	118,796
		TOTAL	5,035,500		.32		1,611,360

* Rounded to nearest thousand.

** Initial delivery ratios were based on a curve developed for northwest Missouri by Finney (27). Adjusted delivery ratios based on the modified delivery ratio curve, Figure 33.

V. SOIL LOSS - SEDIMENT YIELD COMPARISON

This section displays estimates of soil loss and sediment yield in formats useful to identifying sediment problems and causes.

The data is displayed by river seasons and the major grain size groupings clay-silt-sand and gravel. These breaks are necessary to assessing the adverse impacts of sediment. Examples: (1) the adverse impact of sediment on turbidity problems in water treatment is commonly overriden at the Alton, Illinois, water treatment plant in July and August by algae blooms, (2) silt and sand deposition is most adverse to fish during spawning, and (3) the adverse effects of sand and gravel on dredging are most pronounced during periods of low flow.

Prerequisites to allowing these comparisons were:

(1) Estimation of grain size class distribution for the predominant upland soils in each hydrologic catloging unit. Table 22 was prepared by tabulating the available grain size data and calculating average percent grain size class distributions.

(2) Calculations of percentage grain size class distributions for sediment in transit. Table 36 shows the percent grain size class distribution of transported sediment by hydrologic units.

Data to allow making these comparisons was sparse. The limited gage data used in estimating seasonal distribution of sediment by grain size class is shown in Table 35. The displays in this section are intended only to give some perspective of upland soil loss impacts on sediment in transit in the Mississippi River.

TABLE 22 -- Estimated Percent by Grain Size Classes* of Predominant Upland Soils

AREA	Hydrologic Units	D.A. (Mi.^{2})	CLAY		SILT		SAND	GRAVEL
			0.002 mm	0.002 to 0.004 mm	0.004 to 0.016 mm	0.016 to 0.062 mm	0.062 to 2.00 mm	2.00 mm
Salt River	07110005 07110006 07110007	2282	19%	16%	26%	22%	16%	1%
Cuivre River	07110008 07110009	1803	19%	14%	25%	24%	17%	1%
Western Tributaries (Lock and Dams 22-25)	07110004	1883	19%	12%	28%	22%	18%	1%
Western Tributaries (St. Louis- St. Genevieve)	07140101	1590	17%	13%	28%	22%	16%	4%
Meramec River	07140102 07140103 07104104	3980	14%	12%	28%	17%	21%	8%
Saline and Whitewater Rivers	07140105 07140107	2886	18%	15%	28%	19%	16%	4%

*Lane (30)

TABLE 23 -- Estimated Average Annual Soil Loss by Grain Size Classes for Hydrologic Cataloging Unit 07110004

	SOIL LOSS (TONS)	TONS SOIL LOSS BY GRAIN SIZE CLASSES*		
		CLAY < .004 m.m.	SILT .004 to .062 m.m.	SAND & GRAVEL >0.62 m.m.
Urban or Built-Up Land	41,000	12,710	20,500	7,790
Agricultural Land	12,309,000	3,815,790	6,154,500	2,338,710
Rangeland	1,000	310	500	190
Forest Land	138,000	42,780	69,000	26,220
Barren Land	16,000	4,960	8,000	3,040
Streambanks	245,000	75,950	122,500	46,550
Gullies	734,000	227,540	367,000	139,460
TOTAL	13,484,000	4,180,040	6,742,000	2,561,960

* Grain size analyses of soil samples from the predominant upland soils were compared arrive at an estimate of percent grain size class composition of upland soils. Th percentage clay - 31%, silt - 50%, sand and gravel - 19% was applied to erosion sources arrive at tons soil loss by grain size classes.

TABLE 24 -- Estimated Average Annual Soil Loss by Grain Size Classes for Hydrologic Cataloging Unit 07110005

	SOIL LOSS (TONS)	TONS SOIL LOSS BY GRAIN SIZE CLASSES*		
		CLAY $<$ .004 m.m.	SILT .004 to .062 m.m.	SAND & GRAVEL $>$0.62 m.m.
Urban or Built-Up Land	13,000	4,550	6,240	2,210
Agricultural Land	4,613,000	1,614,550	2,214,240	784,210
Rangeland	0	0	0	0
Forest Land	238,000	83,300	114,240	40,460
Barren Land	4,000	1,400	1,920	680
Streambanks	113,000	39,550	54,240	19,210
Gullies	339,000	118,650	162,720	57,630
TOTAL	5,320,000	1,862,000	2,553,600	904,400

* Grain size analyses of soil samples from the predominant upland soils were compared to arrive at an estimate of percent grain size class composition of upland soils. This percentage clay - 35%, silt - 48%, sand and gravel - 17% was applied to erosion sources to arrive at tons soil loss by grain size classes.

TABLE 25 -- Estimated Average Annual Soil Loss by Grain Size Classes for Hydrologic Cataloging Unit 07110006

	SOIL LOSS (TONS)	TONS SOIL LOSS BY GRAIN SIZE CLASSES*		
		CLAY $< .004$ m.m.	SILT .004 to .062 m.m.	SAND & GRAVEL > 0.62 m.m.
Urban or Built-Up Land	26,000	9,100	12,480	4,420
Agricultural Land	6,268,000	2,193,800	3,008,640	1,065,560
Rangeland	1,000	350	480	170
Forest Land	321,000	112,350	154,080	54,570
Barren Land	17,000	5,950	8,160	2,890
Streambanks	154,000	53,900	73,920	26,180
Gullies	463,000	162,050	222,240	78,710
TOTAL	7,250,000	2,537,500	3,480,000	1,232,500

* Grain size analyses of soil samples from the predominant upland soils were compared t arrive at an estimate of percent grain size class composition of upland soils. Thi percentage clay - 35%, silt - 48%, sand and gravel - 17% was applied to erosion sources t arrive at tons soil loss by grain size classes.

TABLE 26 -- Estimated Average Annual Soil Loss by Grain Size Classes for Hydrologic Cataloging Unit 07110007

	SOIL LOSS (TONS)	TONS SOIL LOSS BY GRAIN SIZE CLASSES*		
		CLAY < .004 m.m.	SILT .004 to .062 m.m.	SAND & GRAVEL > 0.62 m.m.
Urban or Built-Up Land	8,000	2,800	3,840	1,360
Agricultural Land	3,287,000	1,150,450	1,577,760	558,790
Rangeland	200	70	100	30
Forest Land	307,000	107,450	147,360	52,190
Barren Land	10,000	3,500	4,800	1,700
Streambanks	51,000	17,850	24,480	8,670
Gullies	202,000	70,700	96,960	34,340
TOTAL	3,865,200	1,352,820	1,855,300	657,080

* Grain size analyses of soil samples from the predominant upland soils were compared to arrive at an estimate of percent grain size class composition of upland soils. This percentage clay - 35%, silt - 48%, sand and gravel - 17% was applied to erosion sources to arrive at tons soil loss by grain size classes.

TABLE 27 -- Estimated Average Annual Soil Loss by Grain Size Classes for Hydrologic Cataloging Unit 07110008

	SOIL LOSS (TONS)	TONS SOIL LOSS BY GRAIN SIZE CLASSES*		
		CLAY < .004 m.m.	SILT .004 to .062 m.m.	SAND & GRAVEL > 0.62 m.m.
Urban or Built-Up Land	24,000	7,920	11,760	4,320
Agricultural Land	5,609,000	1,850,970	2,748,410	1,009,620
Rangeland	1,000	330	490	180
Forest Land	221,000	72,930	108,290	39,780
Barren Land	1,000	330	490	180
Streambanks	238,000	78,540	116,620	42,840
Gullies	79,000	26,070	38,710	14,220
TOTAL	6,173,000	2,037,090	3,024,770	1,111,140

* Grain size analyses of soil samples from the predominant upland soils were compared t arrive at an estimate of percent grain size class composition of upland soils. Thi percentage clay - 33%, silt - 49%, sand and gravel - 18% was applied to erosion sources t arrive at tons soil loss by grain size classes.

TABLE 28 -- Estimated Average Annual Soil Loss by Grain Size Classes for Hydrologic Cataloging Unit 07110009

	SOIL LOSS (TONS)	TONS SOIL LOSS BY GRAIN SIZE CLASSES*		
		CLAY < .004 m.m.	SILT .004 to .062 m.m.	SAND & GRAVEL > 0.62 m.m.
Urban or Built-Up Land	89,000	29,370	43,610	16,020
Agricultural Land	1,848,000	609,840	905,520	332,640
Rangeland	0	0	0	0
Forest Land	68,000	22,440	33,320	12,240
Barren Land	2,000	660	980	360
Streambanks	116,000	38,280	56,840	20,880
Gullies	39,000	12,870	19,110	7,020
TOTAL	2,162,000	713,460	1,059,380	389,160

* Grain size analyses of soil samples from the predominant upland soils were compared to arrive at an estimate of percent grain size class composition of upland soils. This percentage clay - 33%, silt - 49%, sand and gravel - 18% was applied to erosion sources to arrive at tons soil loss by grain size classes.

TABLE 29 -- Estimated Average Annual Soil Loss by Grain Size Classes for Hydrologic Cataloging Unit 07140101

	SOIL LOSS (TONS)	TONS SOIL LOSS BY GRAIN SIZE CLASSES* CLAY $<$ .004 m.m.	SILT .004 to .062 m.m.	SAND & GRAVEL $>$0.62 m.m.
Urban or Built-Up Land	231,000	69,300	115,500	46,200
Agricultural Land	7,177,000	2,153,100	3,588,500	1,435,400
Rangeland	100	30	50	20
Forest Land	918,000	275,400	459,000	183,600
Barren Land	57,000	17,100	28,500	11,400
Streambanks	102,000	30,600	51,000	20,400
Gullies	102,000	30,600	51,000	20,400
TOTAL	8,587,100	2,576,130	4,293,550	1,717,420

* Grain size analyses of soil samples from the predominant upland soils were compared t arrive at an estimate of percent grain size class composition of upland soils. Thi percentage clay - 30%, silt - 50%, sand and gravel - 20% was applied to erosion sources t arrive at tons soil loss by grain size classes.

TABLE 30 -- Estimated Average Annual Soil Loss by Grain Size Classes for Hydrologic Cataloging Unit 07140102

	SOIL LOSS (TONS)	TONS SOIL LOSS BY GRAIN SIZE CLASSES*		
		CLAY < .004 m.m.	SILT .004 to .062 m.m.	SAND & GRAVEL > 0.62 m.m.
Urban or Built-Up Land	63,000	16,380	28,350	18,270
Agricultural Land	2,083,000	541,580	937,350	604,070
Rangeland	500	130	225	145
Forest Land	983,000	255,580	442,350	285,070
Barren Land	98,000	25,500	44,100	28,400
Streambanks	137,000	35,600	61,650	39,750
Gullies	137,000	35,600	61,650	39,750
TOTAL	3,501,500	910,370	1,575,675	1,015,455

* Grain size analyses of soil samples from the predominant upland soils were compared to arrive at an estimate of percent grain size class composition of upland soils. This percentage clay - 26%, silt - 45%, sand and gravel - 29% was applied to erosion sources to arrive at tons soil loss by grain size classes.

TABLE 31 -- Estimated Average Annual Soil Loss by Grain Size Classes for Hydrologic Cataloging Unit 07140103

	SOIL LOSS (TONS)	TONS SOIL LOSS BY GRAIN SIZE CLASSES*		
		CLAY $< .004$ m.m.	SILT .004 to .062 m.m.	SAND & GRAVEL > 0.62 m.m.
Urban or Built-Up Land	10,000	2,600	4,500	2,900
Agricultural Land	1,472,000	382,720	662,400	426,880
Rangeland	1,000	260	450	290
Forest Land	174,000	45,240	78,300	50,460
Barren Land	8,000	2,080	3,600	2,320
Streambanks	53,000	13,780	23,850	15,370
Gullies	53,000	13,780	23,850	15,370
TOTAL	1,771,000	460,460	796,950	513,590

* Grain size analyses of soil samples from the predominant upland soils were compared t. arrive at an estimate of percent grain size class composition of upland soils. Thi percentage clay - 26%, silt - 45%, sand and gravel - 29% was applied to erosion sources t arrive at tons soil loss by grain size classes.

TABLE 32 -- Estimated Average Annual Soil Loss by Grain Size Classes for Hydrologic Cataloging Unit 07140104

	SOIL LOSS (TONS)	TONS SOIL LOSS BY GRAIN SIZE CLASSES* CLAY < .004 m.m.	SILT .004 to .062 m.m.	SAND & GRAVEL > 0.62 m.m.
Urban or Built-Up Land	13,000	3,380	5,850	3,770
Agricultural Land	1,014,000	263,640	456,300	294,060
Rangeland	200	52	90	58
Forest Land	493,000	128,180	221,850	142,970
Barren Land	164,000	42,640	73,800	47,560
Streambanks	62,000	16,120	27,900	17,980
Gullies	62,000	16,120	27,900	17,980
TOTAL	1,808,200	470,132	813,690	524,378

* Grain size analyses of soil samples from the predominant upland soils were compared to arrive at an estimate of percent grain size class composition of upland soils. This percentage clay - 26%, silt - 45%, sand and gravel - 29% was applied to erosion sources to arrive at tons soil loss by grain size classes.

TABLE 33 -- Estimated Average Annual Soil Loss by Grain Size Classes for Hydrologic Cataloging Unit 07140105

	SOIL LOSS (TONS)	TONS SOIL LOSS BY GRAIN SIZE CLASSES*		
		CLAY < .004 m.m.	SILT .004 to .062 m.m.	SAND & GRAVEL > 0.62 m.m.
Urban or Built-Up Land	22,000	7,260	10,340	4,400
Agricultural Land	7,621,000	2,514,930	3,581,870	1,524,200
Rangeland	1,000	330	470	200
Forest Land	394,000	130,020	185,180	78,800
Barren Land	52,000	17,160	24,440	10,400
Streambanks	203,000	66,990	95,410	40,600
Gullies	203,000	66,990	95,410	40,600
TOTAL	8,496,000	2,803,680	3,993,120	1,699,200

* Grain size analyses of soil samples from the predominant upland soils were compared to arrive at an estimate of percent grain size class composition of upland soils. This percentage clay - 33%, silt - 47%, sand and gravel - 20% was applied to erosion sources to arrive at tons soil loss by grain size classes.

3LE 34 -- Estimated Average Annual Soil Loss by Grain Size Classes for Hydrologic Cataloging Unit 07140107

	SOIL LOSS (TONS)	TONS SOIL LOSS BY GRAIN SIZE CLASSES*		
		CLAY < .004 m.m.	SILT .004 to .062 m.m.	SAND & GRAVEL >0.62 m.m.
Jrban or Built-Up Land	8,000	2,640	3,760	1,600
\gricultural Land	4,179,000	1,379,070	1,964,130	835,800
langeland	500	165	235	100
'orest Land	531,000	175,230	249,570	106,200
3arren Land	7,000	2,310	3,290	1,400
itreambanks	155,000	51,150	72,850	31,000
;ullies	155,000	51,150	72,850	31,000
TOTAL	5,035,500	1,661,715	2,366,685	1,007,100

*rain size analyses of soil samples from the predominant upland soils were compared to ive at an estimate of percent grain size class composition of upland soils. This centage clay - 33%, silt - 47%, sand and gravel - 20% was applied to erosion sources to ive at tons soil loss by grain size classes.

TABLE 35 -- Summary of Available Gage Data on Seasonal Distribution and Grain Size Class Distributions of Suspended Sediment Discharge

SEASONAL DISTRIBUTION OF SUSPENDED SEDIMENT DISCHARGE IN PERCENT

RIVER	GAGE LOCATIONS	RECORD	RIVER SEASONS Dec-Jan-Feb	Mar-Apr-May-Jun	Jul-Aug Sept	Oct-Nov
Middle Fk. Salt	Duncans Bridge, MO	1980-1981	5%	57%	38%	--*
Middle Fk. Salt	Paris, MO	1980-1981	1%	53%	46%	--
Youngs Ck.	Mexico, MO	1980-1981	--	42%	58%	--*
S. Fk. Salt	Santa Fe, MO	1980-1981	--	46%	54%	--
Salt	Hunnewell, MO	1980-1981	6%	61%	33%	--
Bay Creek	Nebo, IL	1940-1980	7%	55%	30%	8%
		1979-1980	--	57%	42%	--
Mississippi	Alton, IL	1980-1981	4%	51%	44%	1%
Missouri	Hermann, MO	1973-1978	19%	52%	14%	15%
Mississippi	St. Louis, MO	1980-1981	4%	52%	39%	5%
Meramec	Eureka, MO	1980-1981*	1%	98%*	No data	1%
Saline Creek	Minnith, MO	1980-1981	2%	82%	15%	1%
Mississippi	Thebes, IL	1980-1981	5%	43%	48%	4%

GRAIN SIZE CLASS DISTRIBUTION OF SUSPENDED SEDIMENT DISCHARGE IN PERCENT

RIVER	GAGE LOCATION	RECORD	NO. OF SAMPLES	GRAIN SIZE CLASSES $<$ 0.004 m.m.	0.004-0.062 m.m.	$>$ 0.062 m.m.
Mississippi	Hannibal, MO	1943-1980	63	35%	56%	9%
S. Fk. Salt	Santa Fe, MO	1980-1981	3	70%	26%	4%
N. Fk. Salt	Hunnewell, MO	1980-1981	6	65%	22%	13%
Salt	New London, MO	1980-1981	3	64%	29%	7%
Bay Creek	Nebo, IL	1951-1980	58	37%	60%	3%
Bay Creek	Nebo, IL	1979-1980	9	57%	42%	1%
Illinois	Valley City, IL	1979-1980	5	55%	31%	14%
Mississippi	Alton, IL	1980-1981	3	65%	30%	5%
Missouri	Hermann, MO	1973-1980	292	22%	29%	49%
Mississippi	St. Louis, MO	1980-1981	2	54%	32%	14%
Kaskaskia	Venedy, IL	1979-1980	4	65%	33%	2%
Mississippi	Chester, IL	1980-1981	3	48%	37%	15%
Big Muddy	Murphysboro, IL	1979-1980	2	70%	26%	4%
Mississippi	Thebes, IL	1980-1981	3	31%	45%	24%

* Incomplete record.

TABLE 36 -- Estimated Average Annual Sediment Yields

HYDROLOGIC CATALOGING UNITS	SEDIMENT YIELD (TONS)	*ESTIMATED TONS SEDIMENT YIELD AS		
		CLAY < .004 m.m.	SILT .004 to .062 m.m.	SAND & GRAVEL** > .062 m.m.
07110004	4,064,540	1,503,880	2,438,724	121,936
07110005	1,808,800	904,400	813,960	90,440
07110006	2,320,000	1,160,000	1,044,000	116,000
07110007	1,314,168	657,084	591,376	65,708
07110008	1,975,360	987,680	888,912	98,768
07110009	756,700	378,350	340,515	37,835
07140101	2,490,259	1,245,130	1,120,616	124,513
07140102	485,470	218,462	218,462	48,546
07140103	251,418	113,138	113,138	25,142
07140104	271,259	122,067	122,067	27,125
07140105	2,463,840	1,231,920	1,108,728	123,192
07140107	1,611,360	805,680	725,112	80,568

e compositions of sediment loads were determined from sediment gage data and adjusted r each hydrologic cataloging unit by percent composition. This percentage was plied to the estimated sediment yield. Gages studied were Bay Creek at Nebo, linois, Salt River near Hunnewell, Missouri, Salt River at New London, Missouri, Big ddy at Murphysboro, Illinois, Kaskaskia River at Venedy, Illinois, and Illinois River Valley City, Illinois.

e sand and gravel estimate, intended as a best estimate of total sand and gravel eld, is based on the percent > .062 m.m. fraction of suspended sediment discharge alyses. Inadequate data on bedload transit and errors in the estimated sediment elds did not warrant further adjustment.

TABLE 37 -- Comparison of Average Annual Soil Loss to Average Annual Sediment Yield

HYDROLOGIC CATALOGING UNITS	Av. An. ESTIMATED SOIL LOSS IN TONS			Av. An. ESTIMATED SEDIMENT YIELD IN TONS			ESTIMATED DELIVERY RATIOS			
	CLAY < .004m.m.	SILT .004-.062m.m.	SAND & GRAVEL > .062m.m.	CLAY < .004m.m.	SILT .004-.062m.m.	SAND & GRAVEL > .062m.m.	CLAY	SILT	SAND & GRAVEL	ALL SOIL-SED.
07110004	4,180,040	6,742,000	2,561,960	1,503,880	2,438,724	121,936	.36	.36	.05	.30
07110005	1,862,000	2,553,600	904,400	904,400	813,960	90,440	.49	.32	.10	.34
07110006	2,537,500	3,480,000	1,232,500	1,160,000	1,044,000	116,000	.46	.30	.09	.32
07110007	1,352,820	1,855,300	657,080	657,084	591,376	65,708	.49	.32	.10	.34
07110008	2,037,090	3,024,770	1,111,140	987,680	888,912	98,768	.48	.29	.09	.32
07110009	713,460	1,059,380	389,160	378,350	340,515	37,835	.53	.32	.10	.35
07140101	2,576,130	4,293,550	1,717,420	1,245,130	1,120,616	124,513	.48	.26	.07	.29
07140102	910,370	1,575,675	1,015,455	218,462	218,462	48,546	.24	.14	.05	.14
07140103	460,460	796,950	513,590	113,138	113,138	25,142	.25	.14	.05	.14
07140104	470,132	813,690	524,378	122,067	122,067	27,125	.26	.15	.05	.15
07140105	2,803,680	3,993,120	1,699,200	1,231,920	1,108,728	123,192	.44	.28	.07	.29
07140107	1,661,715	2,366,685	1,007,100	805,680	725,112	80,568	.48	.31	.08	.32

TABLE 38 -- Estimated Seasonal Soil Loss* by Grain Size Classes

HYDROLOGIC CATALOGING UNITS	DEC.-JAN.-FEB.			MAR.-APR.-MAY-JUNE			JULY-AUG.-SEPT.			OCT.-NOV.			TOTAL SOIL LOSS (TONS)
	CLAY	SILT	SAND & GRAVEL	CLAY	SILT	SAND & GRAVEL	CLAY	SILT	SAND & GRAVEL	CLAY	SILT	SAND & GRAVEL	
07110004	209,002	337,100	128,098	1,295,813	2,090,020	794,207	2,090,020	3,371,000	1,280,980	585,205	943,880	358,675	13,484,000
07110005	93,100	127,680	45,220	788,040	1,072,512	379,848	819,281	1,123,584	397,936	167,580	229,824	81,396	5,320,000
07110006	126,927	173,452	61,677	1,065,802	1,461,652	517,701	1,116,553	1,531,229	542,351	228,427	313,252	110,977	7,250,000
07110007	67,641	92,765	32,854	568,184	779,225	275,975	595,240	816,330	289,117	121,754	166,977	59,138	3,865,200
07110008	122,225	181,486	66,668	631,497	937,680	344,453	1,018,545	1,512,387	555,569	264,821	393,221	144,448	6,173,000
07110009	42,808	63,562	23,349	221,173	328,407	120,640	356,730	529,691	194,581	92,750	137,719	50,590	2,162,000
07140101	180,330	300,550	120,220	1,030,444	1,717,416	686,971	953,169	1,588,608	635,449	412,183	686,971	274,789	8,987,100
07140102	63,726	110,296	71,079	364,158	630,270	406,177	336,848	583,001	375,714	145,660	252,104	162,467	3,501,500
07140103	32,233	55,786	35,951	184,184	318,779	205,437	170,370	294,871	190,030	73,674	127,511	82,174	1,771,000
07140104	32,910	56,958	36,707	188,052	325,477	209,751	173,949	301,065	194,019	75,221	130,191	83,900	1,808,200
07140105	196,258	279,518	118,944	1,121,471	1,597,252	679,679	1,037,361	1,477,453	628,704	448,588	638,899	271,873	8,496,000
07140107	116,320	165,668	70,497	664,686	946,673	402,840	614,836	875,673	372,627	265,875	378,669	161,136	5,035,500

*Seasons were divided to fit sediment in transit in the Mississippi since the goal is to assess the effects of upland soil loss on sediment in transit in the Mississippi. Average Annual EI percentages for areas 16 and 18 were used from Table 6 in Agriculture Handbook No. 537 to proportion sediment by seasons (29).

TABLE 39 -- Estimated Seasonal Sediment Yield* in Tons by Grain Size Classes

HYDROLOGIC CATALOGING UNITS	DEC.-JAN.-FEB.			MAR.-APR.-MAY-JUNE			JULY-AUG.-SEPT.			OCT.-NOV.			TOTAL SEDIMENT YIELD
	CLAY	SILT	SAND & GRAVEL	CLAY	SILT	SAND & GRAVEL	CLAY	SILT	SAND & GRAVEL	CLAY	SILT	SAND & GRAVEL	
07110004	105,272	170,711	8,536	827,134	1,341,298	67,065	451,164	731,617	36,580	120,310	195,098	9,755	4,064,540
07110005	63,308	56,977	6,331	497,420	447,678	49,742	271,320	244,188	27,132	72,352	65,117	7,235	1,808,800
07110006	81,200	73,080	8,120	638,000	574,200	63,800	348,000	313,200	34,800	92,800	83,520	9,280	2,320,000
07110007	45,996	41,396	4,600	361,396	325,257	36,139	197,125	177,413	19,712	52,567	47,310	5,257	1,314,168
07110008	69,138	62,224	6,914	543,224	488,902	54,322	296,304	266,674	29,630	79,014	71,112	7,902	1,975,360
07110009	26,484	23,836	2,648	208,093	187,283	20,809	113,505	102,154	11,351	30,268	27,242	3,027	756,700
07140101	24,903	22,412	2,490	996,104	896,493	99,611	211,672	190,505	21,167	12,451	11,206	1,245	2,490,259
07140102	2,185	2,185	485	196,615	196,615	43,692	17,477	17,477	3,884	2,185	2,185	485	485,470
07140103	1,132	1,132	251	101,824	101,824	22,628	9,051	9,051	2,010	1,132	1,132	251	251,418
07140104	1,221	1,221	271	109,860	109,860	24,413	9,765	9,765	2,170	1,221	1,221	271	271,259
07140105	24,638	22,175	2,464	985,537	886,982	98,553	209,426	188,484	20,943	12,319	11,087	1,232	2,463,840
07140107	16,114	14,502	1,611	644,543	580,090	64,454	136,966	123,269	13,697	8,057	7,251	806	1,611,360

*Since a primary goal is to identify the effects of the hydrologic units studied on sediment in transit in the Mississippi River, seasons were chosen that reflect sediment periods of the Mississippi. Breakdowns of grain size classes were estimated from gage data. Gage data at Bay Crek, Nebo, Illinois, Saline Creek, Minnith, Missouri, and Salt River, Hunnewell, Missouri, were studied in estimating the seasonal distribution of sediment.

TABLE 40 -- Estimated Seasonal Effects of Sediment Yield From GREAT III E&SW Group Study Area on Mississippi River Sediment Discharge* at Alton, Illinois**

HYDROLOGIC CATALOGING UNITS	DEC.-JAN.-FEB.			MAR.-APR.-MAY-JUNE			JULY-AUG.-SEPT.			OCT.-NOV.			AVERAGE PERCENT CONTRIBUTION
	CLAY	SILT	SAND & GRAVEL	CLAY	SILT	SAND & GRAVEL	CLAY	SILT	SAND & GRAVEL	CLAY	SILT	SAND & GRAVEL	
	Percent Contribution												
07110004	4.68	4.86	0.99	4.19	5.06	1.17	11.22	12.13	6.91	13.39	11.58	4.34	5.65
07110005	2.81	1.62	0.73	2.52	1.69	0.87	6.75	4.05	5.13	8.06	3.87	3.22	2.51
07110006	3.61	2.08	0.94	3.23	2.16	1.12	8.52	5.19	6.58	10.33	4.96	4.13	3.22
07110007	2.04	1.18	0.53	1.83	1.23	0.63	4.90	2.94	3.73	5.85	2.81	2.34	1.83
07110008	3.07	1.77	0.80	2.75	1.84	0.95	7.37	4.42	5.60	8.80	4.22	3.52	2.74
07110009	1.18	0.68	0.31	1.05	0.71	0.36	2.82	1.69	2.15	3.37	1.62	1.35	1.05
TOTAL	17.39	12.19	4.30	15.57	12.69	5.10	41.58	30.42	30.10	49.80	29.06	18.90	17.00

*Study area consists of Hydrologic Cataloging Units 07110004 to 07110009, 07140101 to 07140105, and 07140107.

**Based on an estimated 32 million tons of sediment yield to the Alton, Illinois, gage on the Mississippi River. Seasonal distribution of sediment discharge at Hannibal, Missouri, and available grain size analyses at Hannibal were used to distribute the estimated sediment yield of 32 million tons by season and grain size. The data was adjusted to fit an overall estimated average annual sediment budget contribution of 17 percent from the upstream hydrologic cataloging units to the Alton, Illinois, gage.

TABLE 41 -- Estimated Seasonal Effects of Sediment Yield from GREAT III E&SW Group Study Area on Mississippi River Sediment Discharge* at St. Louis, Missouri**

HYDROLOGIC CATALOGING UNITS	DEC.-JAN.-FEB.			MAR.-APR.-MAY-JUNE			JULY-AUG.-SEPT.			OCT.-NOV.			AVERAGE PERCENT CONTRIBUTION
	CLAY	SILT	SAND & GRAVEL	CLAY	SILT	SAND & GRAVEL	CLAY	SILT	SAND & GRAVEL	CLAY	SILT	SAND & GRAVEL	
	Percent Contribution												
07110004	5.38	6.02	0.17	2.17	2.57	0.18	1.57	1.96	0.12	4.68	4.83	0.17	1.66
07110005	3.23	2.01	0.13	1.30	0.86	0.14	0.95	0.66	0.09	2.82	1.61	0.13	0.74
07110006	4.15	2.58	0.16	1.67	1.10	0.17	1.22	0.84	0.12	3.61	2.07	0.16	0.95
07110007	2.35	1.46	0.09	0.95	0.62	0.10	0.69	0.47	0.07	2.04	1.17	0.09	0.54
07110008	3.53	2.19	0.14	1.42	0.94	0.15	1.03	0.71	0.10	3.07	1.75	0.14	0.81
07110009	1.35	0.84	0.05	0.55	0.36	0.06	0.39	0.27	0.04	1.18	0.68	0.05	0.31
TOTAL	19.99	15.10	0.74	8.06	6.45	0.70	5.85	4.91	0.54	17.40	12.11	0.74	5.01

*Study area consists of Hydrologic Cataloging Units 07110004 to 07110009, 07140101 to 07140105, and 07140107.

**Based on statistical analysis of 1966-1980 gage data, the average suspended sediment discharge was 115,000,000 tons. Seasonal distribution of this 115,000,000 tons was based on 1980-1981 gage data. The grain size distribution by season was based on weighted averaging of data at Hermann, Missouri, and Hannibal, Missouri. The estimated sediment yield to the Mississippi River from the upstream hydrologic cataloging units were used as a first estimate of the percent contribution to the St. Louis gage. This estimate was adjusted to fit the overall estimated average annual sediment budget contribution of 5 percent from the upstream hydrologic cataloging units to the St. Louis gage.

TABLE 42 -- Estimated Seasonal Effects of Sediment Yield from GREAT III E&SW Study Area on Mississippi River Sediment Discharge* at Chester, Illinois**

HYDROLOGIC CATALOGING UNITS	DEC.-JAN.-FEB.			MAR.-APR.-MAY-JUNE			JULY-AUG.-SEPT.			OCT.-NOV.			AVERAGE PERCENT CONTRIBUTION
	CLAY	SILT	SAND & GRAVEL	CLAY	SILT	SAND & GRAVEL	CLAY	SILT	SAND & GRAVEL	CLAY	SILT	SAND & GRAVEL	
	Percent Contribution												
07110004	5.36	6.00	0.17	2.16	2.56	0.18	1.57	1.96	0.12	4.67	4.81	0.17	1.65
07110005	2.22	2.00	0.13	1.30	0.86	0.13	0.95	0.65	0.09	2.81	1.61	0.13	0.33
07110006	2.85	2.57	0.16	1.66	1.10	0.17	1.21	0.84	0.12	3.60	2.06	0.23	0.95
07110007	2.34	1.45	0.09	0.95	0.62	0.10	0.69	0.47	0.07	2.04	1.17	0.09	0.53
07110008	3.52	2.18	0.14	1.42	0.94	0.15	1.03	0.71	0.10	3.06	1.75	0.14	0.80
07110009	1.35	0.84	0.05	0.54	0.36	0.06	0.40	0.27	0.04	1.17	0.67	0.05	0.31
07140101	1.27	0.78	0.05	2.60	1.71	0.27	0.74	0.51	0.07	0.48	0.28	0.02	1.01
07140102	0.11	0.08	0.01	0.52	0.37	0.12	0.06	0.05	0.01	0.09	0.05	0.01	0.20
07140103	0.06	0.04	--	0.26	0.19	0.06	0.03	0.02	--	0.04	0.03	--	0.10
07140104	0.06	0.04	--	0.29	0.21	0.07	0.03	0.03	0.01	0.05	0.03	--	0.11
TOTAL	19.14	15.98	0.80	11.70	8.92	1.31	6.71	5.51	0.63	18.01	12.46	0.84	5.99

*Study area consists of Hydrologic Cataloging Units 07110004 to 07110009, 07140101 to 07140105, and 07140107.

**An additive sediment yield of 116.1 million tons was used for the Chester gage. The average suspended sediment discharge analysis of 108.3 million tons was out of line with the statistical analysis of 115.0 million tons for St. Louis and the gage analysis of 115.4 million tons for Thebes. The same percentage distribution of sediment was used as for the St. Louis display. The estimated sediment yield to the Mississippi River from the upstream hydrologic cataloging units was used as a first estimate of the percent contribution of sediment yield to the Chester gage. This estimate was adjusted to fit the overall estimated average annual sediment budget of 6 percent contribution from the upstream hydrologic cataloging units to the Chester gage.

TABLE 43 -- Seasonal Effects of Sediment Yield from GREAT III E&SW Group Study Area on Mississippi River Sediment Discharge* at Thebes, Illinois**

HYDROLOGIC CATALOGING UNITS	DEC.-JAN.-FEB.			MAR.-APR.-MAY-JUNE			JULY-AUG.-SEPT.			OCT.-NOV.			AVERAGE PERCENT CONTRIBUTION
	CLAY	SILT	SAND & GRAVEL	CLAY	SILT	SAND & GRAVEL	CLAY	SILT	SAND & GRAVEL	CLAY	SILT	SAND & GRAVEL	
	Percent Contribution												
07110004	3.19	3.57	0.10	1.30	2.12	0.21	1.06	1.32	0.08	4.34	4.48	0.16	1.23
07110005	1.92	1.19	0.07	0.78	0.71	0.16	0.64	0.44	0.06	2.61	1.49	0.12	0.55
07110006	2.46	1.53	0.10	1.01	0.90	0.20	0.82	0.57	0.08	3.35	1.92	0.15	0.70
07110007	1.39	0.87	0.05	0.57	0.51	0.11	0.46	0.32	0.05	1.89	1.08	0.08	0.40
07110008	2.09	1.30	0.08	0.86	0.77	0.17	0.70	0.48	0.07	2.85	1.63	0.13	0.60
07110009	0.80	0.50	0.03	0.33	0.30	0.07	0.27	0.18	0.02	1.09	0.62	0.05	0.23
07140101	0.75	0.47	0.03	1.57	1.41	0.31	0.50	0.34	0.05	0.45	0.26	0.02	0.75
07140102	0.07	0.05	0.01	0.31	0.31	0.14	0.04	0.03	0.01	0.08	0.05	0.01	0.15
07140103	0.04	0.02	--	0.16	0.16	0.07	0.02	0.02	--	0.04	0.02	--	0.08
07140104	0.04	0.02	--	0.17	0.17	0.08	0.02	0.02	--	0.04	0.03	--	0.08
07140105	0.75	0.46	0.03	1.55	1.40	0.31	0.49	0.34	0.05	0.45	0.25	0.02	0.75
07140107	0.49	0.30	0.02	1.02	0.92	0.20	0.32	0.22	0.03	0.29	0.17	0.01	0.49
TOTAL	13.99	10.28	0.52	9.63	9.68	2.03	5.34	4.28	0.50	17.48	12.00	0.75	6.01

*Study area consists of Hydrologic Cataloging Units 07110004 to 07110009, 07140101 to 07140105, and 07140107.

**An additive sediment yield of 116.7 million tons was used for the Thebes gage. This additive estimate compares favorably with the 1966-1980 average suspended sediment discharge of 115.4 million tons. The estimated percent distribution of sediment used for the St. Louis gage was adjusted based on the 1980-1981 gage data for Thebes, Illinois. The estimated sediment yield to the Mississippi River from the upstream hydrologic cataloging units was used as a first estimate of the percent contribution of sediment yield to the Thebes gage. This estimate was adjusted to fit the overall estimated average annual sediment budget of 6 percent contribution from the upstream hydrologic cataloging units to the Thebes gage.

VI. STUDY RESULTS

GAGE ANALYSES

The long-term suspended sediment concentration, suspended sediment discharge, and water discharge data for the gages at Hannibal and St. Louis, Missouri, on the Mississippi River and Hermann, Missouri, on the Missouri River were analyzed. The results of these analyses and an ongoing study by the Illinois U.S.G.S. on Bay Creek in Illinois are discussed in this section.

Hannibal, Missouri

The relationship of water discharge to suspended sediment concentration remained fairly consistent from 1944 to 1978, Figure 24. The seasonal nature of Mississippi River suspended sediment discharge is defined by monthly groupings on Figure 25. An average suspended sediment discharge of 19.4 million tons for the period 1966 to 1980 was calculated from a statistically derived average suspended sediment concentration. Keown's (1) calculations of average annual suspended sediment discharge at this station remained fairly constant for the time frames 1953 to 1967 and after 1967.

Hermann, Missouri

A computer plotted display of average annual flow rate and average annual suspended sediment concentration for the time period 1948 to 1973 is shown in Figure 26. Beginning in 1966 average annual suspended sediment concentration declined while average annual flow rate increased, Figure 26. This trend was also documented in monthly flow rates versus monthly suspended sediment concentration displays. Figure 27 shows that average monthly suspended sediment concentration increases with average monthly discharge for the period of record. Figure 27 also shows that suspended sediment concentration and discharge increase, on the average, from January to June and decrease from July to December. Keown (1) has documented at this station a reduction in Missouri River average annual suspended sediment discharge.

The apparent increase in average annual discharge from 1966 to 1974 appears to be an artificial effect caused by reservoir management. The average annual discharge plotted in Figure 26 can be largely explained by the following chronological sequence provided by Paul D. Barber (28).

A drought occurred in the mid 1950's, and from 1953 to 1956 approximately 50 percent of the annual flow volumes were derived from main stem reservoirs. After 1956, higher runoff from the downstream uncontrolled watershed was available while several lakes, both federal and private, were being constructed on the major tributaries, mostly in the Kansas River Basin. The contributing flow volumes from the reservoirs for the period 1957 to 1962 varied from approximately 12 to 33 percent. From 1963 through 1974, the volume of flow derived from the reservoirs and lakes was approximately 45 to 50 percent, except during 1965 and 1969 when the uncontrolled drainage area

Figure 24 -- Yearly Averages of Suspended Sediment Concentration (ppm) and Flow Rate (cfs) for the Years 1944 to 1978 at Hannibal, Missouri (39)

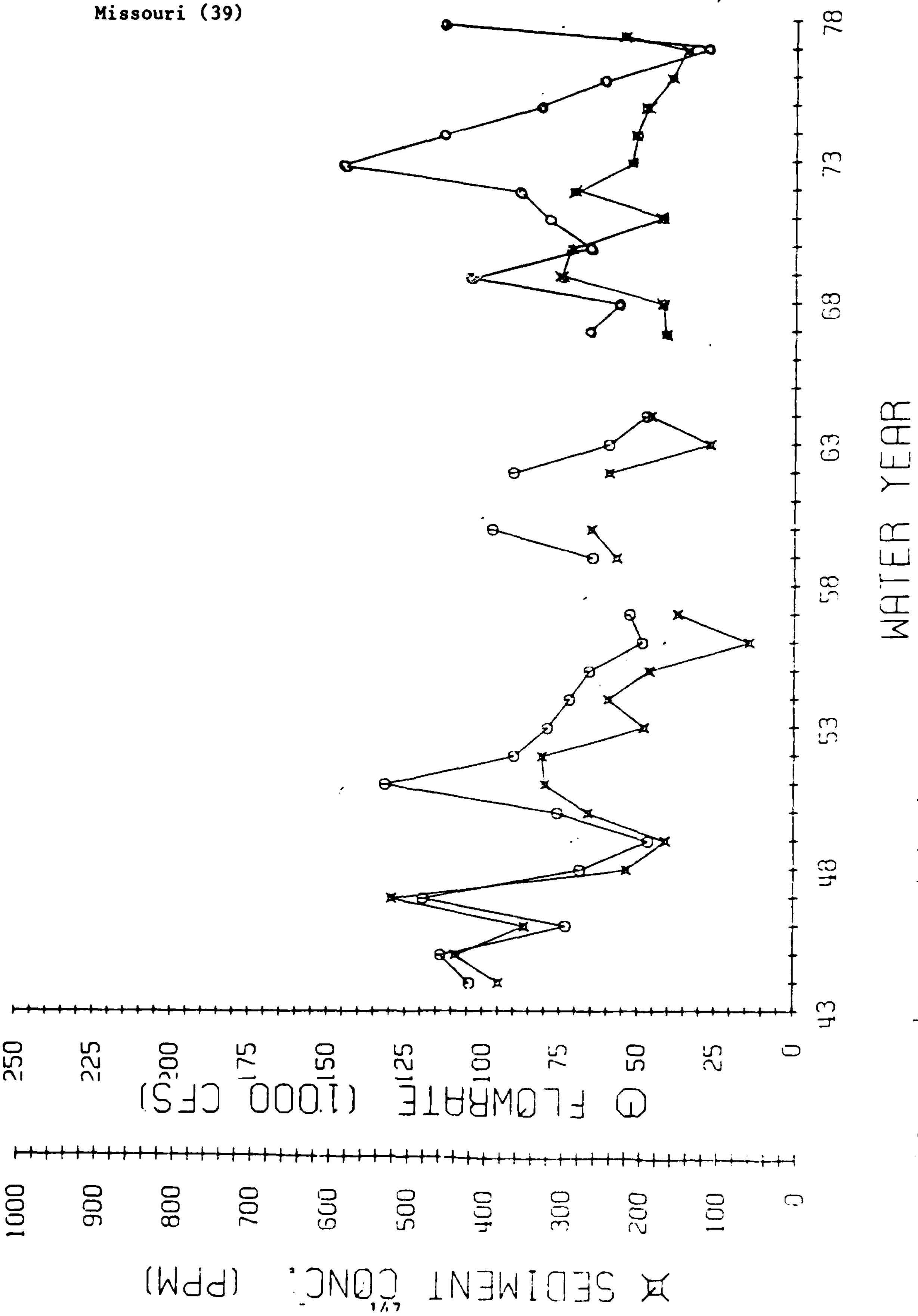


Figure 25 -- Monthly Averages of Suspended Sediment Concentration (ppm) and Flow Rate (cfs) for the Years 1944 to 1978 at Hannibal, Missouri (39)

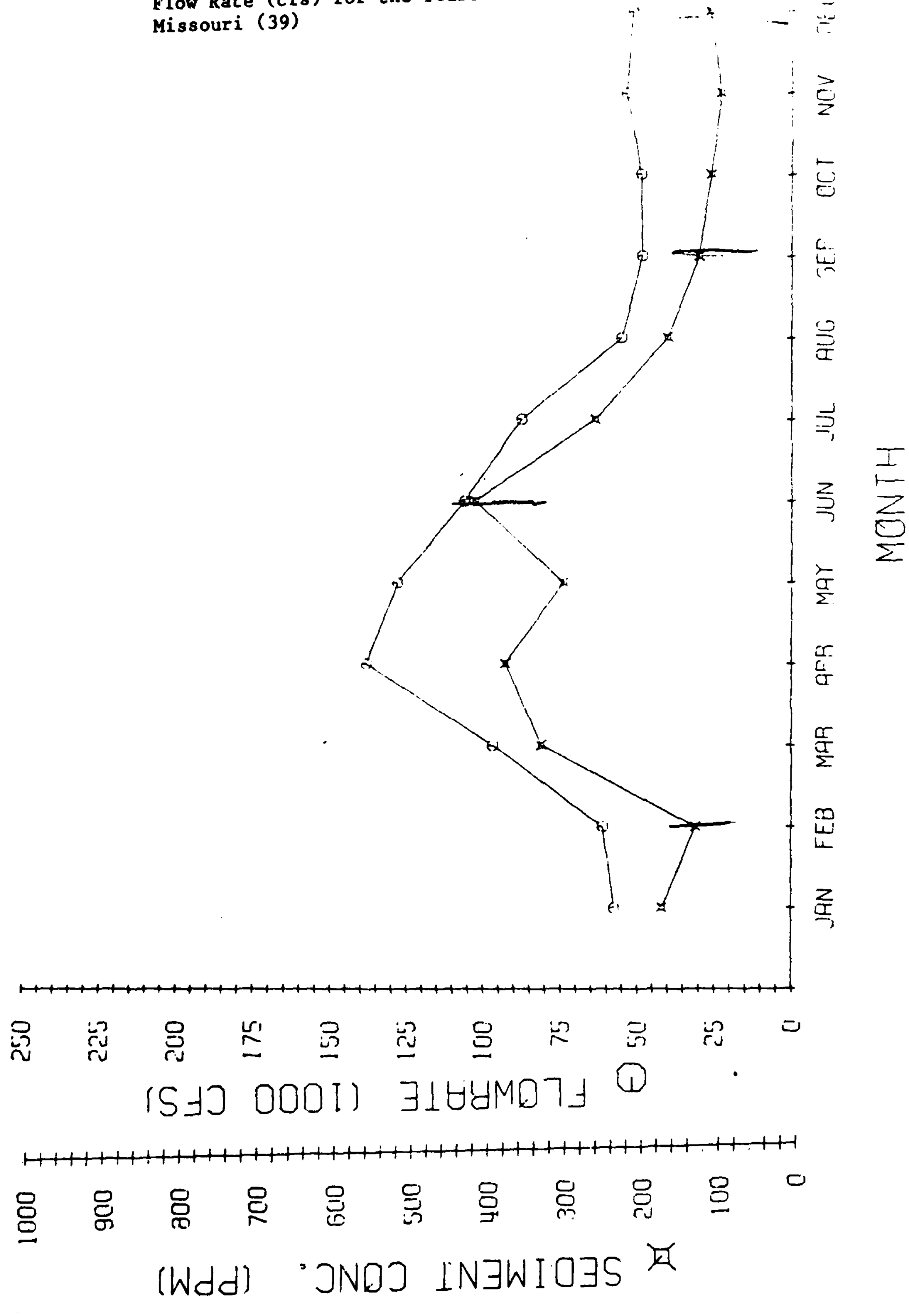


Figure 26 -- Yearly Averages of Suspended Sediment Concentration (ppm) and Flow Rate (cfs) for the Years 1944 to 1973 at Hermann, Missouri (39)

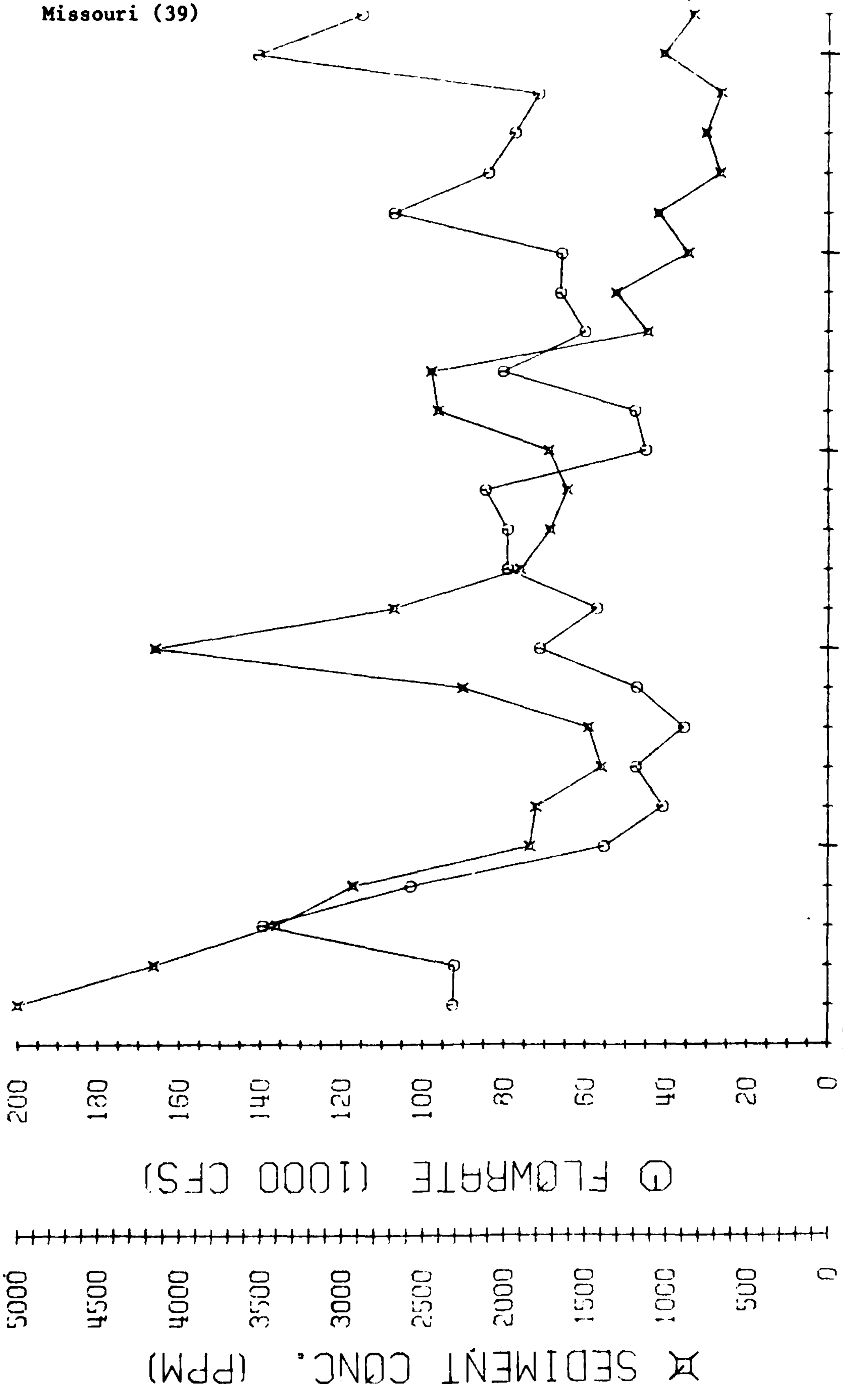
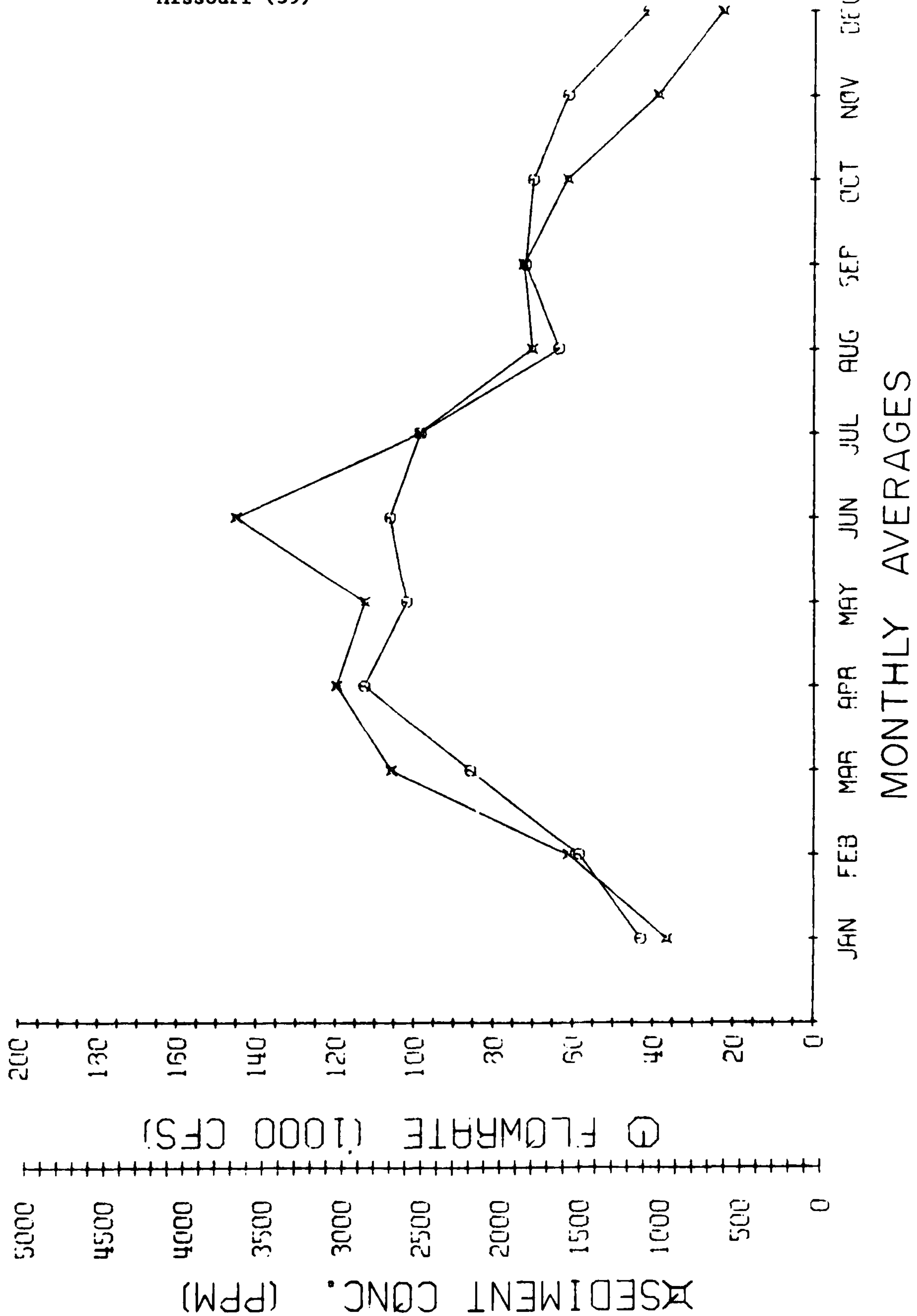


Figure 27 -- Monthly Averages of Suspended Sediment Concentrations (ppm) and Flow Rate (cfs) for the Years 1944 to 1973 at Hermann, Missouri (39)



produced large runoff volumes. Extensive flooding occurred in 1967 and 1973 on the Missouri River, but a large portion of the flow volumes were regulated by the reservoirs and lakes.

The effect of dams on suspended sediment discharge negates the use of suspended data prior to 1966 in estimating present and future sediment concentrations, discharges, and yields. Present average annual and average monthly suspended concentration estimates were calculated from 1966 to 1980 suspended sediment data. Present average annual flow rates were calculated for the period 1948 to 1980. Upstream impoundments are thought to have little effect on annual flow rates. Present average monthly flow rates were calculated for the period 1966 to 1980. A stochastic equation to predict sediment discharge was developed from instantaneous suspended sediment concentrations and flow rates (39).

The following tabular summary provided by Paul D. Barber (28) summarizes the changes in average annual-flow, suspended sediment discharge, and concentration that have occurred at the Hermann gage on the Missouri River.

Period WY	Average Annual Volume 10^6 ac-ft/y	Average Annual Reservoir Release* 10^6 ac-ft/y	Ave. Annual Suspended Sediment Discharge 10^6 tons/y	Average Annual Concentration C ppm
1929-1952	53	6	243	3370
1953-1965	43	15	102	1750
1966-1974	63	29	90	1050

* Included in average annual flow.

St. Louis, Missouri

The suspended sediment discharge of the Mississippi River at St. Louis has remained fairly constant since 1960, Figure 28. Total water discharge appears to be increasing since 1960, Figure 29. The consistency in sediment discharge of the Mississippi River at St. Louis is particularly interesting since the suspended sediment discharge of the Missouri River at Hermann, Missouri, has continued to decline.

Figure 28 -- Suspended Sediment Discharge of Mississippi River at St. Louis, Missouri, 1950 to 1978 (41)

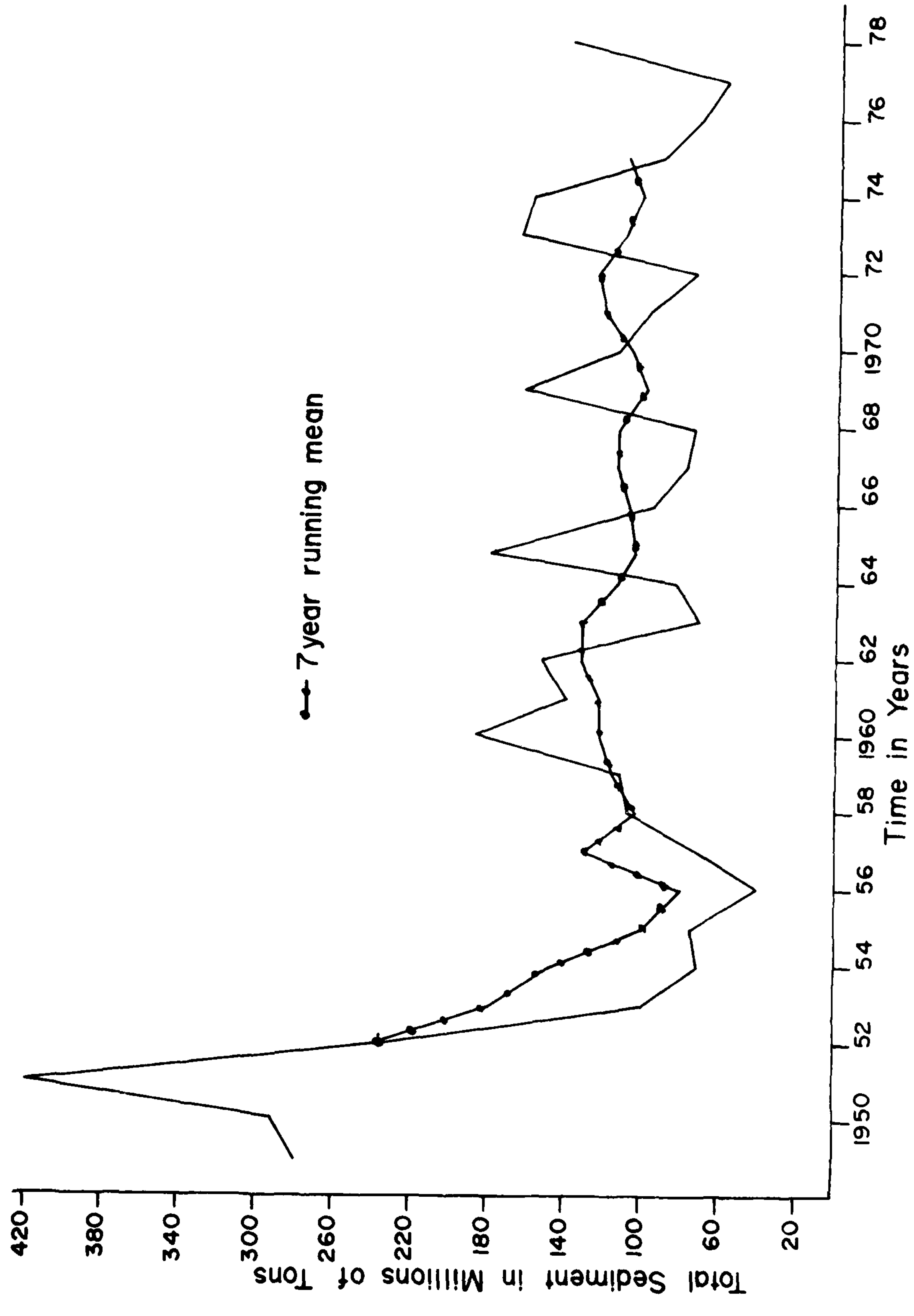
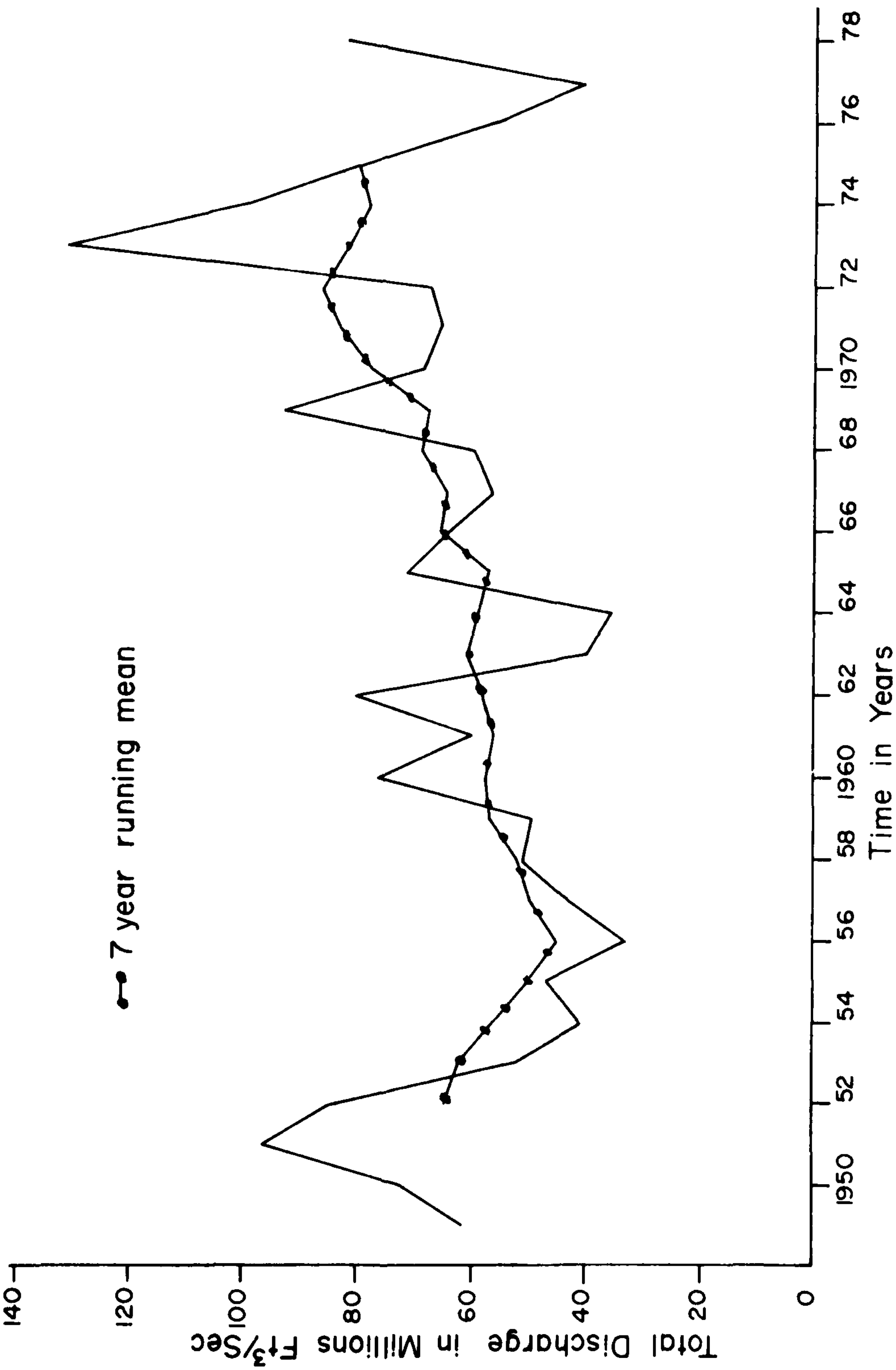


Figure 29 -- Total Water Discharge of Mississippi River at St. Louis, Missouri, 1950 to 1978 (41)



Bay Creek, Illinois

The USGS in Illinois is in the process of preparing a report on this 161 square mile watershed (42). Regression equations have been developed to define monthly correlations between streamflow and sediment discharge (42). The average suspended sediment discharge for water years 1940 to 1980 is 292,400 tons. The average monthly suspended sediment discharge for water years 1940 to 1980 is displayed against average monthly water discharge, agricultural practices, and general ground cover condition for a conventional upland corn, soybean, wheat rotation, Table 44.

TABLE 44 -- Average Monthly Suspended Sediment Discharge Versus Agricultural Practices and Cover Conditions for Bay Creek, Nebo, Illinois, Water Years 1940 to 1980 (24)

Month	Average Monthly Susp. Sediment Discharge Tons/Month	Water Discharge cfs	Conventional Corn (c), Soybeans (s) Wheat (w) Rotation	
			Agricultural Practices	General Ground Cover Condition
October	15,200	1,906	harvest (c,s), shred (c) moldboard plow (c), drill and seed (w), tandem disc and harrow (w)	Fair
November	9,890	1,686		Poor
December	5,500	1,612		Poor
January	5,440	1,922		Snow Cover
February	9,280	2,755		Poor
March	24,100	4,433		Poor
April	43,400	5,190	tandem disc (c,s), moldboard plow (s)	Zero
May	56,700	5,270	tandem disc (c,s), spike tooth harrow (c), plant (c,s), spray (c,s)	Zero
June	45,300	3,780	row cultivate (c,s)	Poor
July	34,500	2,768	harvest (w)	Fair
August	33,900	1,984		Fair
September	18,600	1,725		Fair

STOCHASTIC MODEL

A computer model (39) was developed to analyze flow rate and suspended sediment concentration data from gaging stations at Hannibal and Hermann, Missouri. A log-log type of regression equation was fitted to the daily data for each month with the flow rate considered as the independent variable and suspended sediment concentration as the dependent variable. Since the regression equation accounted for only 50 percent of the variance, it became necessary to add a random component to the regression equation. The data contained a significant number of high outliers, some of which were several times the regressed suspended sediment concentration. These caused a right skew in the data which was removed by fitting log-normal and gamma distributions to the residuals.

Regression analysis ran on suspended sediment concentration versus flow rate for the stations Missouri River at Hermann, Missouri, and Mississippi River at Hannibal, Missouri, gave coefficients of determination (R^2) of 0.50. A R^2 of 0.50 means that the regression equation predicts 50 percent of the total variation about the mean of the dependent variable (suspended sediment concentration).

Once the distribution was fitted to the data, it became possible to employ a Monte Carlo simulation technique to estimate the missing suspended sediment concentration for the flow rate record. The model predicted average annual suspended sediment discharges used in estimating the average annual sediment yields for Hermann, Missouri, and Hannibal, Missouri, shown on Figure 29.

The model (39) at this time does not predict flow rates. If any flow data is missing or flow rates are to be predicted, historical flow records at the study site will have to be analyzed and stochastic parameters estimated. The missing data could then be synthetically sampled by a Monte Carlo simulation technique.

EROSION

The rate of gross erosion ranged from 3 to 11 tons per acre in the 12 hydrologic units. Table 45 displays the total tonnage of estimated soil loss, estimated soil loss by grain size classes, and the estimated soil loss rate for each hydrologic unit, and agricultural soil loss as a percent of total soil loss.

TABLE 45 -- Soil Loss Estimates by Hydrologic Cataloging Units

HYDROLOGIC CATALOGING UNITS	ESTIMATED AVERAGE ANNUAL SOIL LOSS IN TONS				SOIL LOSS RATE T/A	AGRICULTURAL SOIL LOSS AS % TOTAL SOIL LOSS
	CLAY < .004m.m.	SILT .004-.062m.m.	SAND & GRAVEL > .062m.m.	TOTAL		
07110004	4,180,040	6,742,000	2,561,960	13,484,000	11	91
07110005	1,862,115	2,553,757	904,455	5,320,327	9	87
07110006	2,538,248	3,481,026	1,232,862	7,252,136	9	86
07110007	1,352,276	1,854,554	656,820	3,863,650	8	85
07110008	2,037,579	3,025,500	1,111,405	6,174,484	8	91
07110009	713,299	1,059,140	389,073	2,161,512	6	86
07140101	2,576,143	4,293,571	1,717,429	8,587,143	8	84
07140102	910,372	1,575,650	1,015,417	3,501,439	3	59
07140103	460,666	797,302	513,819	1,771,787	3	83
07140104	469,967	813,404	524,193	1,807,564	3	56
07140105	2,803,508	3,992,873	1,699,097	8,495,478	8	90
07140107	1,661,969	2,367,043	1,007,254	5,036,266	6	83
TOTALS AND AVERAGES	21,566,182	32,555,820	13,333,784	67,455,786	8	85

Nearly 68 million tons of soil are dislodged annually in the 12 hydrologic cataloging units from Saverton, Missouri, to Cairo, Illinois, bordering the Mississippi River. This dislodged soil, commonly called soil loss, does not all leave the immediate area. Sediment yield, off field soil in transport, is discussed in the following section titled "Sediment."

Hydrologic cataloging unit 07110004 has the largest amount and highest rate of soil loss of the 12 hydrologic cataloging units. Agricultural sheet-rill erosion accounts for 85 percent of the soil loss in the 12 hydrologic cataloging units. Agricultural sheet-rill erosion alone accounts for 77

percent of the dislodged soil. Figure 30 displays the variance in agricultural sheet-rill erosion in the 12 hydrologic unit area. It is worth noting that hydrologic cataloging units 07110004 and 07140101 adjacent to the Mississippi River have the highest agricultural sheet-rill erosion rates. Figure 31 displays the variance in gross erosion in the 12 hydrologic unit area.

Insufficient data was available to assess the impacts of land use changes on sediment. A significant increase in row cropping has occurred in Illinois and Missouri since 1973. However, sediment data on small streams is not available to assess this change. Sediment gages on the Missouri and Mississippi Rivers are affected by too many other variables to identify local changes in land use. An attempt was made to identify the effects of soil bank programs. The soil bank was legislated under two separate programs, the Conservation Reserve (CR) 1957, and the Conservation Adjustment Program (CAP) circa 1966. The maximum affect of the soil bank in Illinois and Missouri occurred around 1960. The effect was not identifiable at sediment gages on the Missouri and Mississippi Rivers.

The high bank of the Mississippi River from Saverton, Missouri, to Cairo, Illinois, was mapped to quantify bank erosion and/or fill (38). Sediment from erosion of the high bank was found to be insignificant to determining a sediment budget for the GREAT III Erosion and Sediment Work Group Study Area. The method chosen to quantify bank erosion and/or fill included a method of re-section using a boom stereoscope. A more exact method of delineation and mapping was prohibited due to costs, availability of equipment, a difference of scale between maps and photos, and the accuracy of existing sediment records (38).

SEDIMENT

Sediment is defined as solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice, and has come to rest on the earth's surface either above or below sea level (36).

Sediment yield is defined as the total sediment outflow from a watershed, measurable at a cross section of reference in a specified period of time (44). Erosion and sediment yield are not synonymous because of progressive deposition of eroded materials from the point of origin to the point of measurement. Sediment discharge is the quantity of sediment, per unit time, measured in dry weight or by volume, carried past any cross section of a stream. Sediment discharge consists of both suspended load and bedload (36).

Sediment delivery ratios are commonly used to predict sediment yields at desired points. A sediment delivery ratio is the percentage relationship between the sediment yield at a specified measuring point in a watershed and the gross, or total, erosion occurring in the watershed upstream from that point (37). Factors that affect this relationship include topography, watershed size, watershed shape, location of eroding areas, soils, stream dimensions, stream density, and climatic conditions.

Figure 30 -- Agricultural Sheet-Rill Erosion, GREAT III Erosion and Sediment Work Group Study Area, Illinois and Missouri

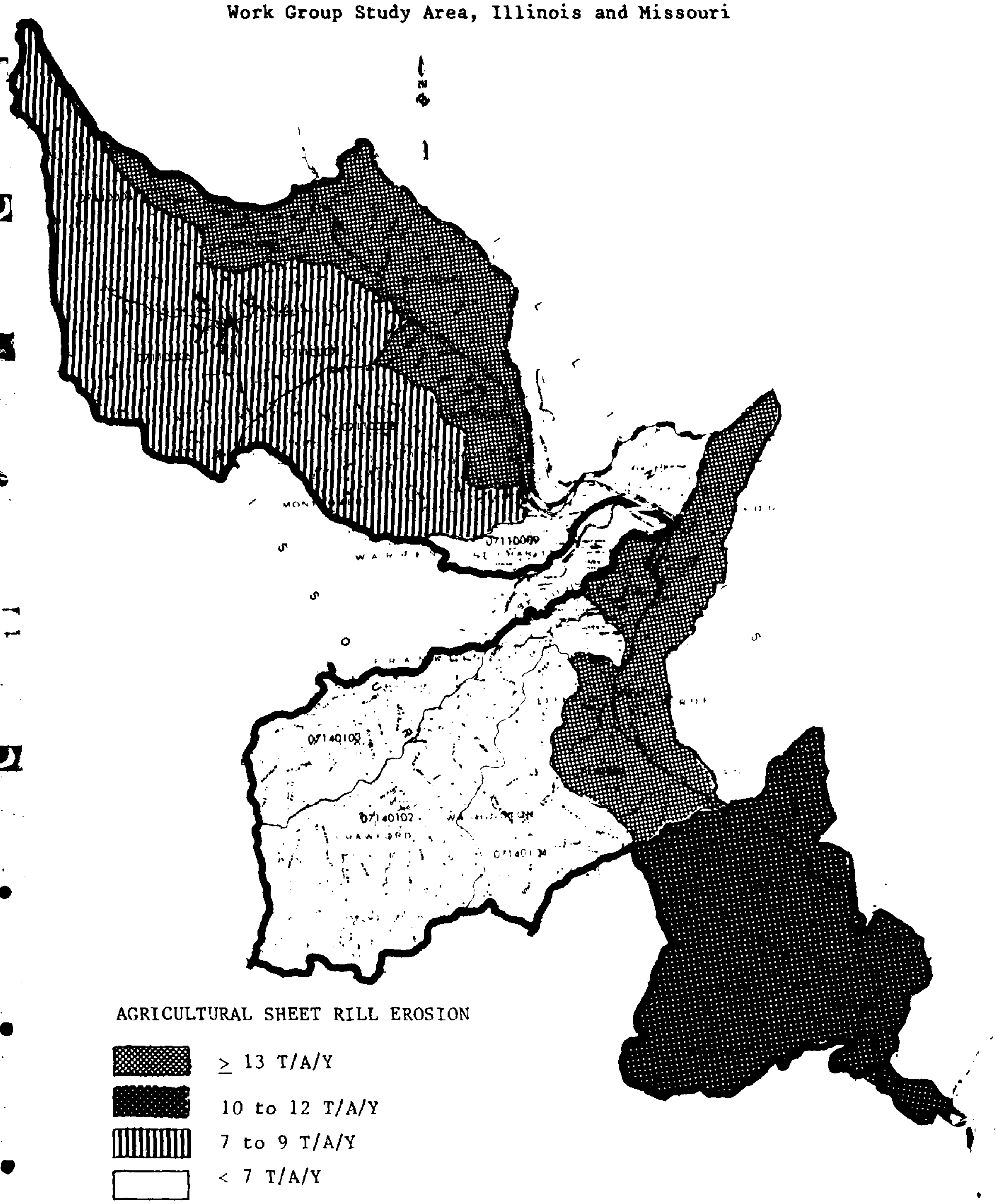
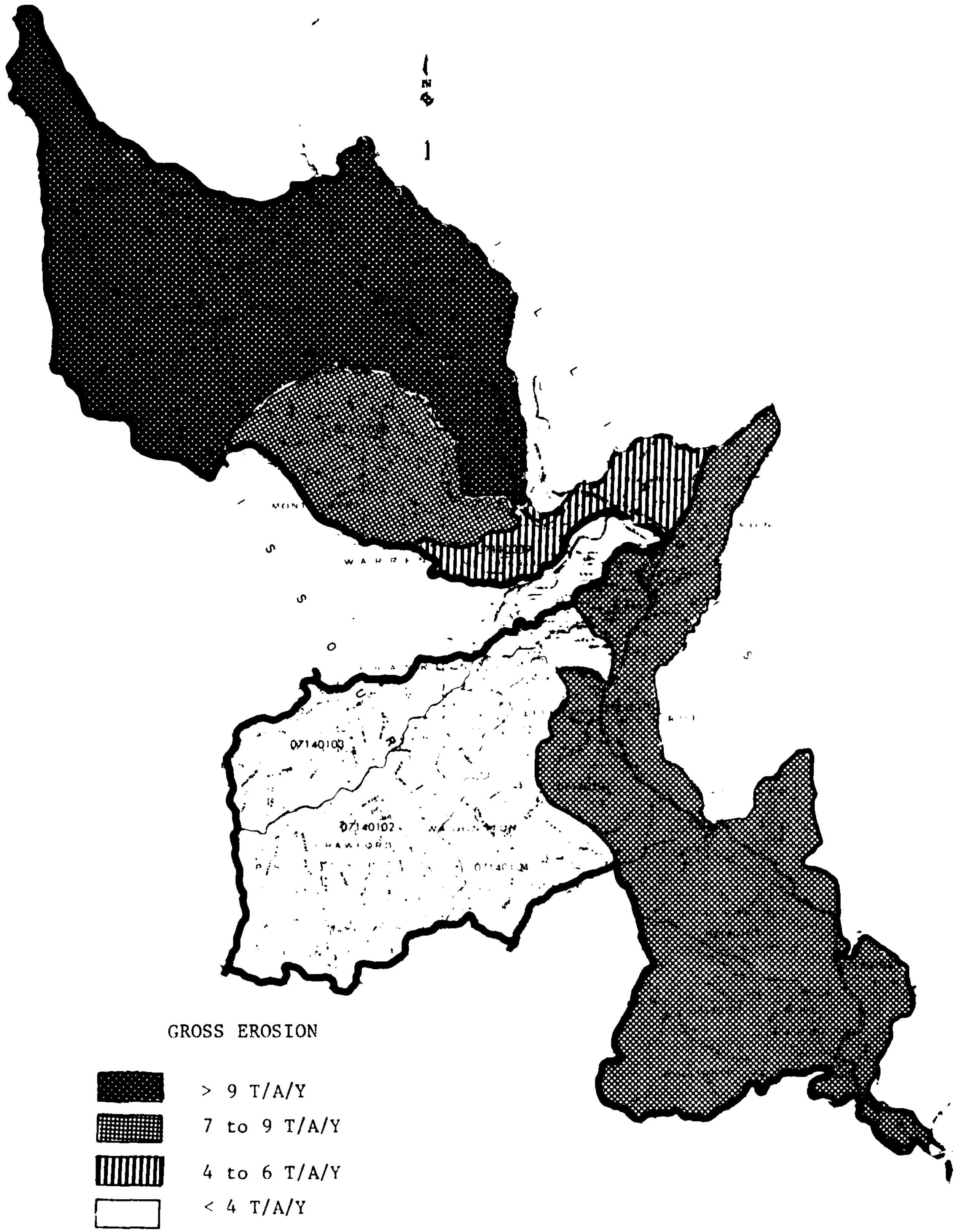


Figure 31 -- Gross Erosion, GREAT III Erosion and Sediment Work Group Study Area, Illinois and Missouri



Roehl (37) developed a sediment delivery ratio curve by analysis of data from the Blackland Prairies, the Red Hills of Texas and Oklahoma, the Missouri Basin Loess Hills, the Mississippi Sand Clay Hills, and the Southeastern Piedmont. Roehl's delivery ratio curve (37) was modified to develop a sediment delivery ratio curve applicable to the 12 hydrologic unit area of this study, Figure 33.

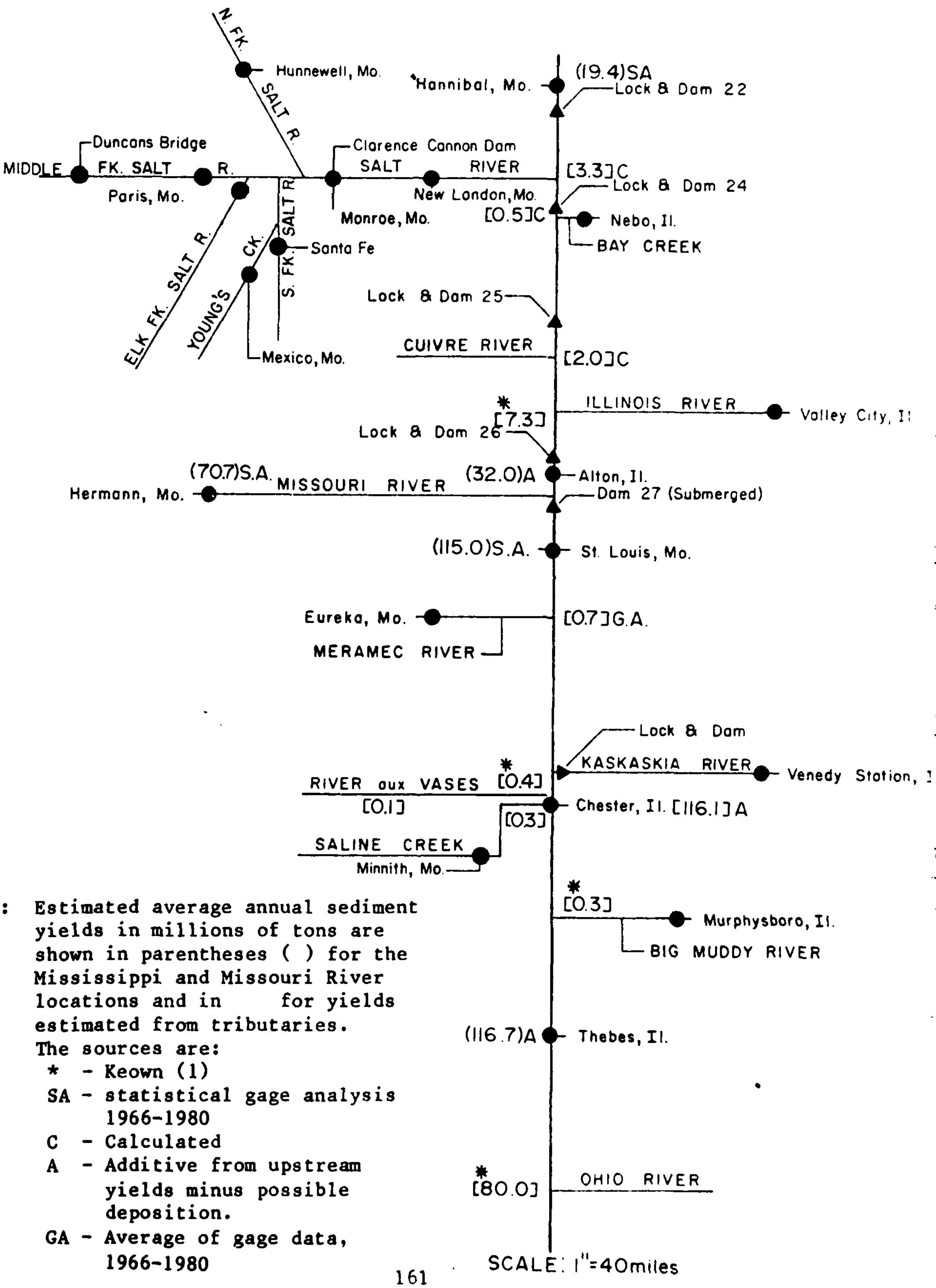
A sediment budget for the study area is graphically displayed in Figure 32. Sources of the estimates of average annual sediment yield are: Keown (1), statistical gage analysis-1966 to 1980 (39), soil loss data calculations additive from upstream yields minus possible deposition, and gage data averages for 1966 to 1980. It is important to note that sediment yield estimates are only intended to be applicable at the point shown. Figure 34 displays the variation in sediment yield across the 12 hydrologic unit area.

Keown (1) documented a change from an average annual suspended-sediment discharge of 320 million tons for the Mississippi River at St. Louis, Missouri, prior to 1953 to 114 million tons after 1967. Main stem dam construction on the Missouri River and in the Kansas drainage area is largely responsible for this reduction. However, sediment discharge of the Mississippi River at St. Louis has remained fairly constant since 1960. Tables 46, 47, and 48 display changes in suspended-sediment discharge of the Missouri River at Hermann, Missouri, for the time frames 1948-1954, 1973-1978, and 1965-1980. Not only has there been a reduction in suspended-sediment discharge, but a change in grain size distribution. Although all grain size fractions have been reduced, the silt and clay fractions have decreased more than the sand fraction. An increase in the proportion of suspended sediment derived from the river bed may account for the increase in percent of the sand fraction.

The seasonal effect of sediment yield from the GREAT III, Erosion and Sediment Work Group Area is most significant at the Alton, Illinois, Mississippi River gage, Table 40. The estimated contribution of nearly 50 percent clay for the river season Oct.-Nov., if correct, should be most significant to water treatment at Alton.

At the Thebes, Illinois, gage, Table 43, on the Mississippi River, the overall estimated contribution of sediment yield from the GREAT III, Erosion and Sediment Work Group Area is only 6 percent.

Figure 32 -- Estimated Sediment Budget, GREAT III Erosion and Sediment Work Group Study Area, Illinois and Missouri



NOTE: Estimated average annual sediment yields in millions of tons are shown in parentheses ( ) for the Mississippi and Missouri River locations and in for yields estimated from tributaries.
The sources are:

- * - Keown (1)
- SA - statistical gage analysis 1966-1980
- C - Calculated
- A - Additive from upstream yields minus possible deposition.
- GA - Average of gage data, 1966-1980

Figure 33 -- Modified Delivery Ratio Curve, GREAT III Erosion and Sediment Work Group Study Area, Illinois and Missouri

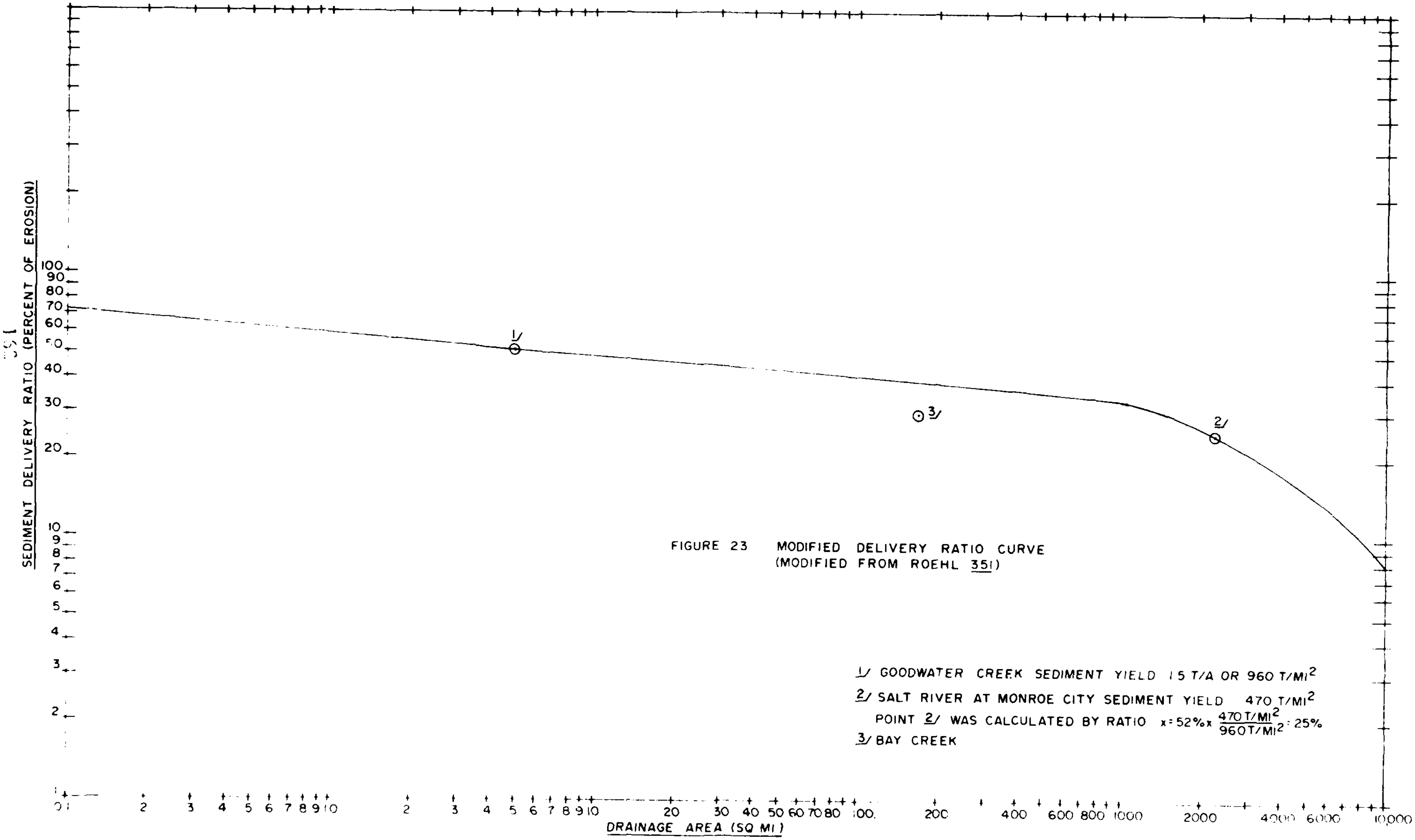


Figure 34 -- Sediment Yield, GREAT III Erosion and Sediment Work Group Study Area, Illinois and Missouri

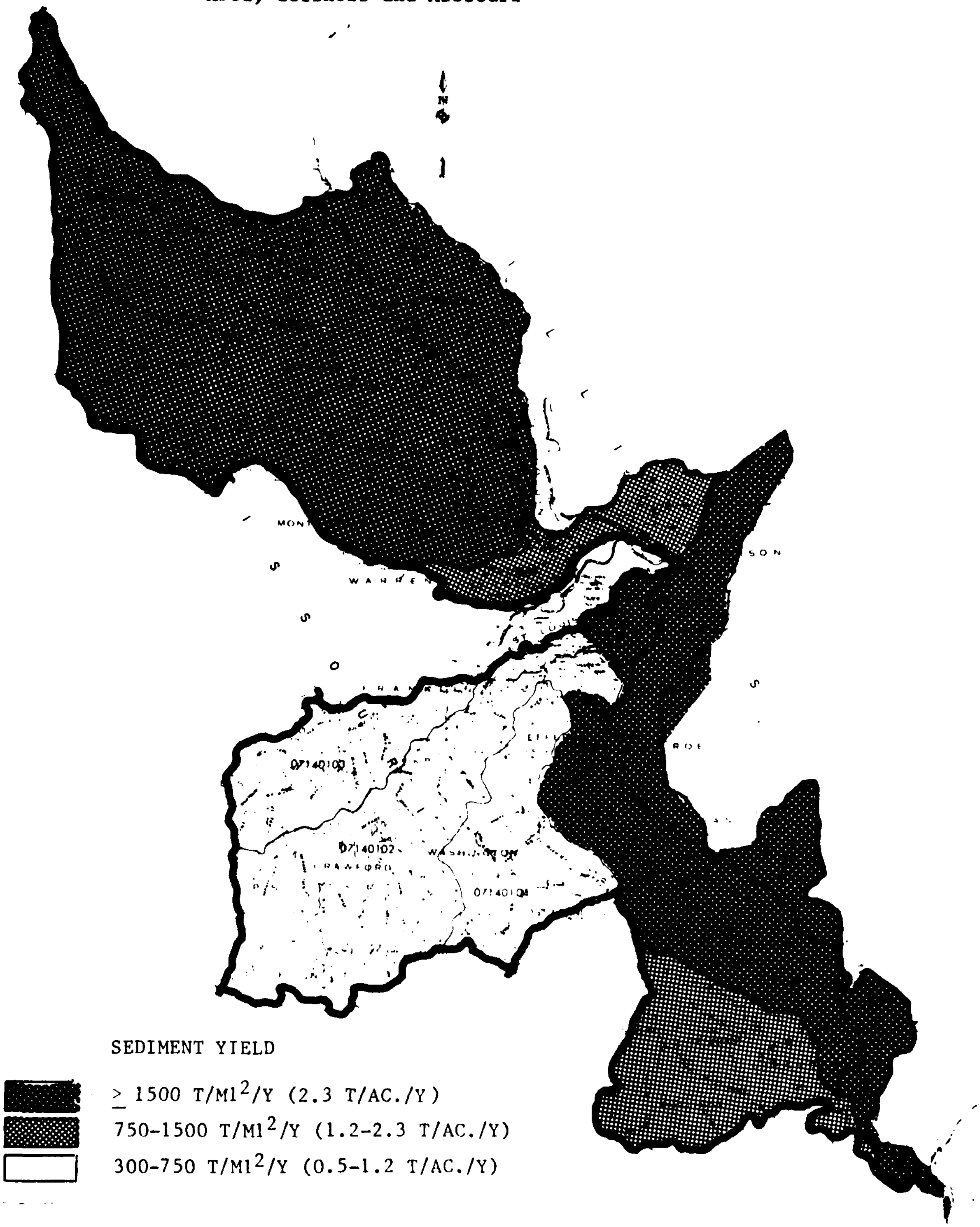


TABLE 46 -- Missouri River at Hermann, Missouri, Suspended Sediment Discharges, 1948-1954

MILLIONS OF TONS

MONTH	TOTAL TONNAGE	AVERAGE TONNAGE	SAND FRACTION	SILT FRACTION	CLAY FRACTION
JAN	23.98	4.00	2.09	1.28	0.63
FEB	55.42	9.24	3.48	3.90	1.87
MAR	146.18	24.36	7.14	10.43	6.80
APR	306.89	51.15	11.00	23.37	16.78
MAY	190.94	31.82	3.34	14.32	14.19
JUN	305.04	50.84	11.24	21.05	18.56
JUL	172.02	28.67	5.93	11.98	10.75
AUG	83.63	13.94	1.62	7.00	5.32
SEP	88.23	14.70	2.19	6.46	6.06
OCT	61.39	10.23	1.71	4.47	4.00
NOV	34.29	5.72	1.29	2.34	2.09
DEC	18.51	3.08	0.92	1.22	0.94
TOTALS	1,486.53	247.76	51.94	107.82	87.99

TABLE 47 -- Missouri River at Hermann, Missouri, Suspended Sediment Discharges, 1973-1978

MILLIONS OF TONS

MONTH	TOTAL TONNAGE	AVERAGE TONNAGE	SAND FRACTION	SILT FRACTION	CLAY FRACTION
JAN	35.38	5.90	4.37	0.77	0.75
FEB	29.04	4.84	2.88	1.07	0.89
MAR	65.16	10.86	5.10	3.37	2.39
APR	63.88	10.65	4.75	3.28	2.62
MAY	41.62	6.94	2.14	2.71	2.09
JUN	51.07	8.51	2.11	3.29	3.16
JUL	26.49	4.41	1.58	1.56	1.26
AUG	13.20	2.20	0.88	0.72	0.60
SEP	21.96	3.66	1.77	1.10	0.79
OCT	39.96	6.66	3.78	1.66	1.21
NOV	26.50	4.42	2.68	1.02	0.71
DEC	17.06	2.84	1.79	0.68	0.38
TOTALS	431.33	71.89	33.84	21.23	16.85

TABLE 48 -- Missouri River at Hermann, Missouri, Suspended Sediment Discharges, 1965-1980

MILLIONS OF TONS*

MONTH	TOTAL TONNAGE	AVERAGE TONNAGE	SAND FRACTION	SILT FRACTION	CLAY FRACTION
JAN	77.70	4.86	3.60	0.64	0.62
FEB	63.66	3.98	2.37	0.88	0.73
MAR	214.25	13.39	6.29	4.15	2.95
APR	226.38	14.15	6.31	4.36	3.48
MAY	114.16	7.13	2.20	2.78	2.15
JUN	217.89	13.62	3.38	5.26	5.05
JUL	141.18	8.82	3.17	3.12	2.52
AUG	45.73	2.86	1.15	0.93	0.78
SEP	88.48	5.53	2.68	1.66	1.19
OCT	78.41	4.90	2.78	1.22	0.89
NOV	59.74	3.73	2.27	0.87	0.60
DEC	31.91	1.99	1.25	0.48	0.26
TOTALS	1,359.48	84.97	37.44	26.35	21.23

*Distribution of monthly tonnages by grain size fractions was done using the average percent breakdown for the period 1973 to 1978.

Physical and Chemical Properties of Sediment

A complete understanding of soil loss-sediment transport and associated contaminants depends on understanding the analyses being used. Differences in analyses being used to measure sediment movement in upland drainage areas and in major streams and rivers hinder the comparability of results. The science of sediment transport has been developed on concepts of discrete particles. Failing to explain sediment transport by direct logic, scientists long ago reverted to empirical relationships developed in laboratory models and field measurements. One wonders if direct logic might not have been more productive if directed toward the natural forms in which particles are transported. The forms in which sediment are transported likely vary with source, transport system, climatic conditions, etc. This may partially explain why coefficients in empirical equations commonly require adjustment when utilized outside the system in which developed.

Eroded soil is known to be transported as soil aggregates. For this reason, ARS scientists, such as Alberts (31), use natural water analyses to quantify sediment movement in upland drainage areas. The downstream persistence of soil aggregates is poorly understood. *USGS particle size analyses of suspended sediment is generally done with a dispersing agent. Since sand-sized aggregates may consist of 90 or more percent silt and clay-sized particles, Alberts (31), the method of analysis chosen seems highly significant to understanding sediment transport.

It is generally accepted that most of the nitrogen and phosphorus transported in runoff is associated with sediment. Alberts (31) makes the case that due to the mode of transport, i.e. in aggregate form, significant quantities of nutrients may be deposited with sand sized aggregates. While the nutrient to sediment ratio increases in the downstream direction due to a higher proportion of transported fines, the total quantity of sediment attached nutrients and the total stream nutrient discharge may decrease. Conversely, downstream attrition of aggregates may increase the surface area of transported sediments allowing more attachment sites for nutrients and diminishing the concentration of nutrients in solution.

The understanding of sediment associated contaminants appears also to be clouded by analysis methodology. Alberts (31) advocates using the external surface area of soil aggregates as an indicator of adsorption capacity. Specific surface area is defined as equal to the external surface area plus the internal surface area of a soil or sediment particle. Recent authors have been lax in their usage of this terminology. Thus, it is not always clear whether they are reporting specific surface area or only external surface area adsorption capacity values. Kennedy (32) stresses the importance of the internal surface area of discreet particles in establishing contaminant equillibria between sediment and water. Kennedy (32) suggests that cation exchange may be the best indicator of adsorption capacity.

To assess the significance of the different analyses on grain size distribution and adsorption versus surface area, SCS scientists at the soil laboratory in Lincoln, Nebraska, conducted analyses on suspended sediment samples from the Missouri River at Hermann, Missouri, the Mississippi River at Hannibal, Missouri, and the Mississippi River at St. Louis, Missouri.

Results of grain size analyses for untreated and treated suspended sediment samples are shown in Table 49. The results of these analyses should be interpreted with caution since only one sample was analyzed from each location and the possibility exists of coagulation following sampling. The 0.0002 to 0.05 m.m. grain size fraction may be transported as aggregates. The 0.05 to 2.0 m.m. grain size fraction of suspended sediment discharge at Hannibal, Missouri, may be transported as aggregates. Aggregate transport of the 0.05 to 2.0 m.m. grain size fraction of suspended sediment discharge at St. Louis does not appear to be occurring and aggregate transport of the 0.05 to 2.0 m.m. fraction does not appear to be a major factor at Hermann, Missouri.

TABLE 49 -- Grain Size Distribution of Untreated and Treated Suspended Sediment Samples from the Missouri River at Hermann, Missouri, and the Mississippi River at Hannibal, Missouri, and St. Louis, Missouri

SAMPLE NO.	TREATMENT*	LOCATION	GRAIN SIZE CLASSES .002m.m.	.0002-.05m.m.	.05-2.0m.m.
81Q1380	Untreated	Missouri River at Hermann, MO	0.9	71.0	28.1
81Q1381	Treated	Missouri River at Hermann, MO	40.2	36.3	23.5
82Q0028	Untreated	Mississippi River at Hannibal, MO	2.2	75.3	22.5
82Q0029	Treated	Mississippi River at Hannibal, MO	33.8	62.3	3.9
82Q0347	Untreated	Mississippi River at St. Louis, MO	5.4	33.2	61.4
92Q0348	Treated	Mississippi River at St. Louis, MO	18.9	19.2	61.9

*USGS rationale for dispersion hydrometer analyses in lieu of natural water analyses includes: (1) lower costs, (2) minimize chemical interference, and (3) standardize laboratory results.

Sediment Effects on Water Treatment

Garin (33) documented the reduction in costs of chemical treatment of water by reducing turbidity. The St. Louis County Water Company on the Missouri River and the water company at Alton, Illinois, on the Mississippi River were selected for studying the effects of sediment on water treatment.

Data collected included turbidity measurements at the intake pumping stations, suspended solid measurements (only at St. Louis County Water Company), and coagulant chemicals used for water treatment. The data was collected for a 10-year period, 1971 to 1980, for both locations.

For the St. Louis Water Company on the Missouri River, linear regression was used to relate turbidity and suspended solid measurements. The correlation coefficients ranged from +0.77 to +0.97. These values were then compared to the correlation coefficients for the linear regression of concentration measurements at Hermann, Missouri, and turbidity measurements at the St. Louis Water Company. The regression was done for a 0-, 1-, and 2-day lag time. Theoretically, the 1-day lag time should represent the highest correlation coefficients because, using a mean velocity of 3 fps and a distance of 60 miles, lag time is approximated to be 29 hours. The correlation coefficients were very close and not significantly different for the three lag times when analyzed on a monthly basis. The range of variance from month to month was +0.43 to +0.91. The average value for all 12 months at 1-day lag time was +0.73.

Although these values are not as high as those for the actual suspended solid measurements at the St. Louis Water Company, they are close enough to justify using the suspended sediment load calculated from the Hermann data to estimate chemical use caused by the Missouri River.

For the Mississippi River at Alton, Illinois, suspended solid measurements are not taken by the water company. However, the Illinois Water Survey (34) developed the following expression to relate suspended solids to turbidity:

$$ss(mg/l) = 2.2 \text{ turbidity (JTU)} - 42.6$$

This expression was developed for samples gathered from the Mississippi River in the vicinity of Alton, and it was assumed that there is always a minimum suspended solids concentration in the river of 10 mg/l. This expression was used to relate suspended sediment concentration to chemical use in the Mississippi River.

Linear regression was done for both locations using the chemical quantities (per million gallons of water) and turbidity measurements. The chemicals analyzed were Ferric Sulfate, Lime, Fluoride, and special polymers, such as Purifloc, Separan, and Nalco. Ferric sulfate is used typically as a chemical coagulant to induce flocculation and resultant precipitation of suspended matter which does not readily settle and sink of its own weight. The recently developed polymers are occasionally used as a filter aid in the filtering and coagulation process. Lime and fluoride are used for water softening. These chemicals react with dissolved chemicals to form insoluble particles which sink to the bottom of settling basins.

The assumption was made that these chemicals added during water treatment reduce the turbidity from the initial measurement at the intake pumping station to a constant $\pm$ 6 JTU's (Jackson Turbidity Units) at the output pumping station. Turbidity measurements were thus treated as the independent variable and chemical quantities as the dependent variable. Each chemical was independently regressed with turbidity.

Each chemical was regressed against turbidity measurements on a monthly basis to determine the best of three possible equations:

x turb vs. y chem	$y = ax + b$
x turb vs. ln (y chem)	$y = ac^{bx}$
ln (x turb) vs. ln (y chem)	$y = ax^{b}$

Generally, the arithmetic expression was the best fit for all chemicals regressed. Results of the regression analysis showed that of the four chemicals, Ferric Sulfate is the only chemical coagulant that can be considered correlated to suspended solids (39).

VII. CONCLUSIONS

On the average, 67 million tons of soil are dislodged annually on the study area uplands. Upland gross erosion ranges from 3 to 11 tons per acre. Agricultural sheet-rill erosion accounts for 85 percent of the dislodged soil. Agricultural sheet-rill erosion is highest in hydrologic cataloging units 07110004 and 07140101. The average cropland soil loss in these areas ranges from 10 to 18 tons per acre.

Sediment yield in the study area is most severe from hydrologic cataloging units 07110004, 07110005, 07110006, 07110007, 07110008, 07140101, and 07140105. The hydrologic cataloging units in the study area are estimated to account for 17 percent of the sediment discharge at Alton, Illinois; 5 percent of the sediment discharge at St. Louis, Missouri; and 6 percent of the sediment discharge at Chester and Thebes, Illinois.

Erosion from the study area hydrologic cataloging units may contribute nearly 50 percent of the clay discharge at the Alton, Illinois, gage on the Mississippi River during October and November. Seasonal analysis of sediment sources needs to be substantiated. The effects of sediment cannot be adequately assessed until seasonally reliable data is available.

The highest tributary suspended sediment concentrations occur during April, May, and June. These are the months of poorest ground cover on cropland.

Erosion of the Mississippi River high bank between Saverton, Missouri, and Cairo, Illinois, was determined to be an insignificant source of sediment in the Mississippi River.

Stochastic equations were developed to predict suspended sediment discharge at the Hermann, Missouri, gage on the Missouri River and the Hannibal, Missouri, gage on the Mississippi River. The general form of these equations is:

$$C = Y \left(\frac{F}{1000}\right)^{S} F.K.T. \quad (45)$$

Where, C = concentration in mg/l
Y = y intercept of the linear regression
F = flow in cfs
S = slope of the linear regression
K = conversion factor to express suspended sediment discharge in tons per day
T = random component

Beginning in 1966, the average annual suspended sediment concentration at the Hermann, Missouri, gage on the Missouri River declined while the average annual flow rate increased. The sand fraction of the suspended sediment discharge of the Missouri River at Hermann, Missouri, has been reduced less than the silt and clay fractions.

The suspended sediment discharge of the Mississippi River at St. Louis has remained constant since 1960 even though the suspended sediment discharge of the Missouri River at Hermann, Missouri continued to decline during this period. The primary cause of reduction in suspended sediment discharge prior to 1960 was dam construction in the Missouri River Basin.

Suspended solids were shown to be correlated to turbidity measurements at the St. Louis County Water Company on the Missouri River and the water company at Alton, Illinois, on the Mississippi River. Of four chemicals added in the water treatment process to facilitate filtering and settling of impurities, only Ferric Sulfate correlated to suspended solids.

Insufficient data was available to assess the impacts of land use changes on sediment. Suspended sediments may retain aggregate forms in the Missouri and Mississippi Rivers.

A complete understanding of soil loss-sediment transport and associated contaminants depends on understanding the analyses being used. Comparison of analyses being used to measure sediment movement in upland drainage areas and in major streams and rivers is often difficult.

VIII. RECOMMENDATIONS

Consistent methodology needs to be adopted by scientists attempting to quantify soil loss and sediment transport. Natural water analyses should be ran in conjunction with conventional dispersed analyses to determine if correlations exist.

Gaging stations need to be distributed from headwaters to stream outlets to monitor physical and chemical changes in sediment.

The relative importance of upland sediment sources needs to be determined to maximize sediment reductions per treatment dollar expended.

Methodology for computing sediment loads needs to be developed to statistically validate published data.

Bedload needs to be quantified. Gridded sonic plots should be conducted over time at selected river locations as a means of quantifying bedload transport. Concurrently, sediment samples should be taken to determine the nature of the recorded particles. Analyses should be made that best depict the natural state of the particles.

The mechanics of sediment and associated contaminant transport need to be re-evaluated based on natural particle characteristics.

In Missouri, install erosion and sediment control measures, land treatment and structural, in the tributary drainage areas to reduce sediment load in the Mississippi River and enhance the life and usefulness of the Clarence Cannon Dam. Prioritization for installation should be based on current planning, applications, and recommendations to be listed in the proposed USDA Salt River Basin report.

In Illinois, install erosion and sediment control measures on the Mississippi River and Lower Illinois River Bluff drainage areas (primarily in Major Land Resource Area 115). This includes parts of Hydrologic Units 07110004, 07130011, 07130003, 07130012, 07110009, 07140101, and 07140105. The majority of this area is included in the area designated in Illinois as Targeted Area No. 2 for Erosion and Sediment Control.

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